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PROCEEDINGS

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OF

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EDWARD J. NOLAN,
Recording Secretary.

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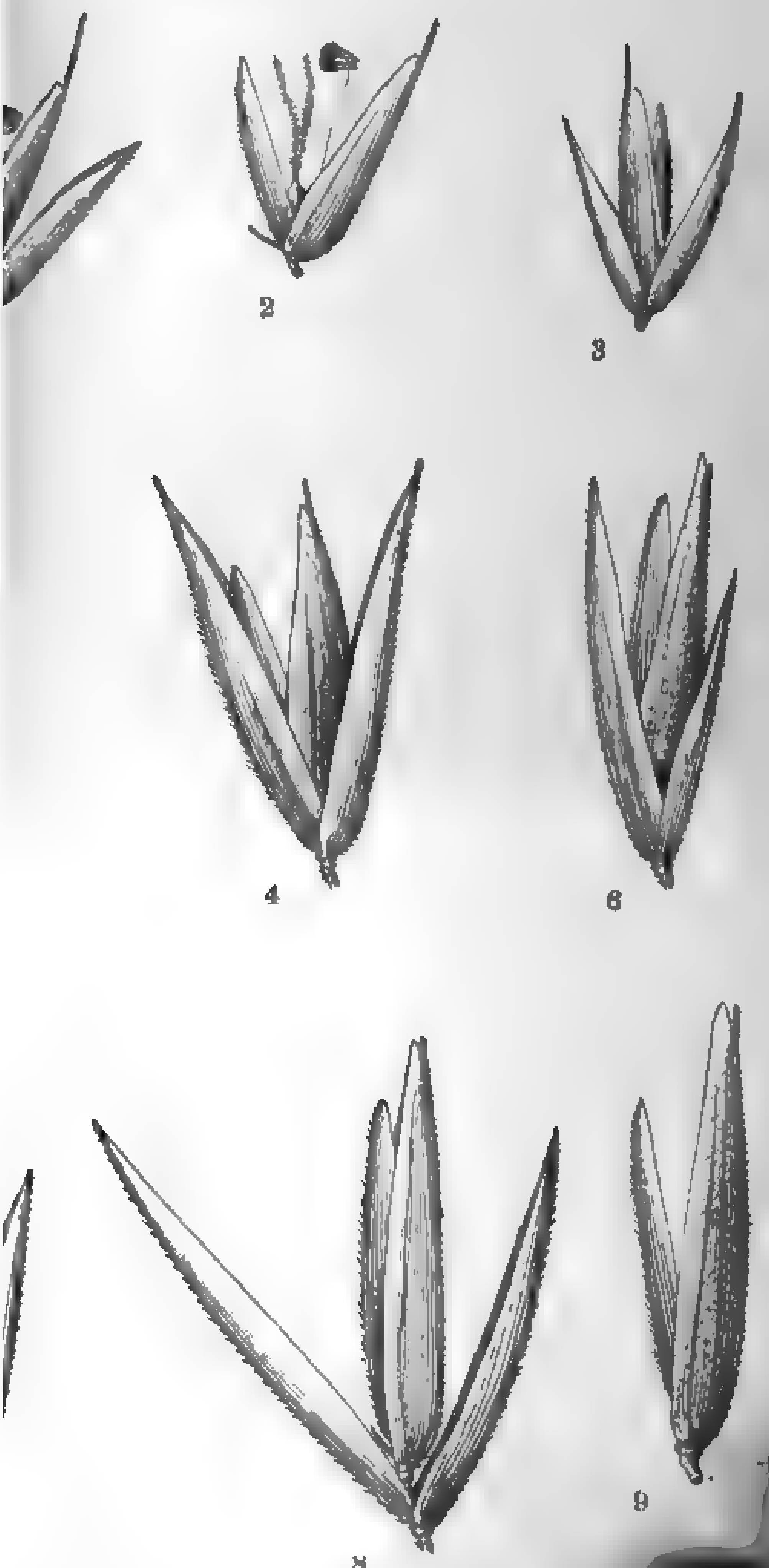

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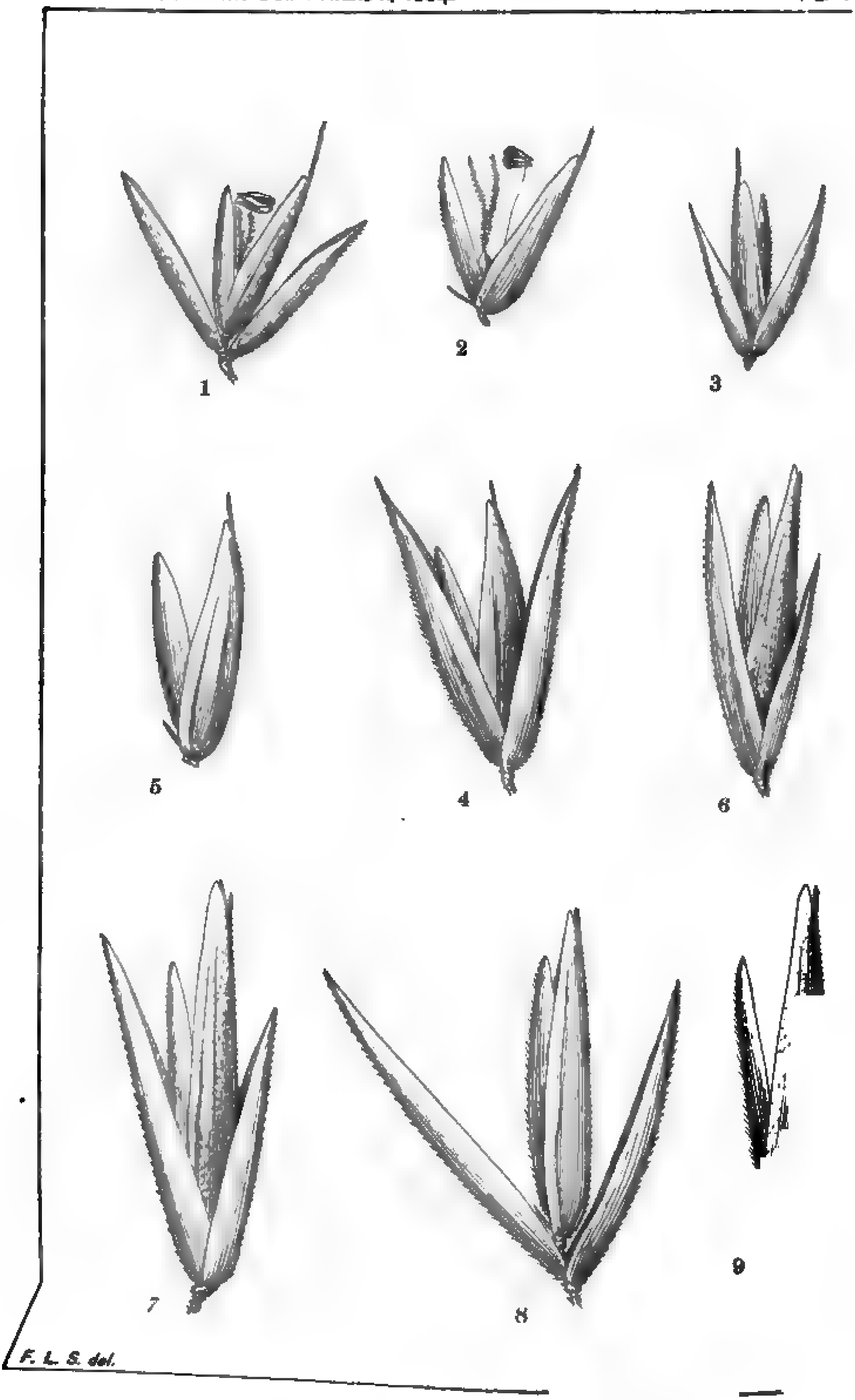
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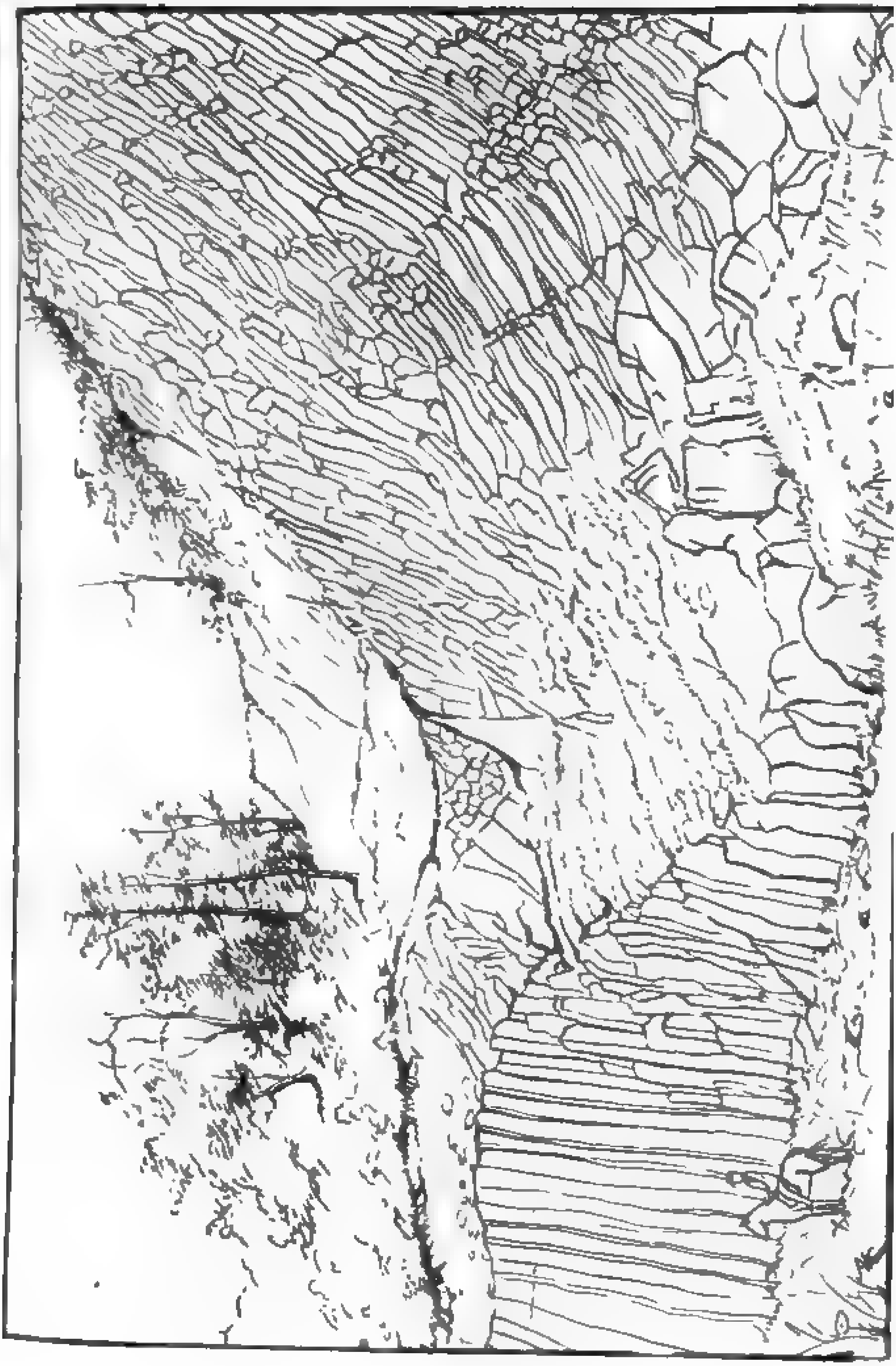

PROCEEDINGS

OF THE

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PHILADELPHIA.

1884.

JANUARY 1, 1884.

The President, Dr. LEIDY, in the chair.

Fourteen persons present.

Ant infected with a Fungus.—Prof. LEIDY exhibited an ant, *Camponotus pennsylvanicus*, which was rigid, with limbs and antennæ extended, as in life, in which condition it was found under the bark of a decaying tree. It was infected with a fungus which spread through every part of the body.

Cassiterite from Black Hills, Dakota.—Prof. LEIDY exhibited specimens of tin ore submitted for examination by Mr. Eltonhead, who reports them to have been obtained at Black Hills, Dakota. They consisted of a mass of granite containing cassiterite, a fragment of quartz with the same, and a mass of pure cassiterite of about one pound weight. Prof. Leidy said he had also seen several pounds of large grains obtained from gold washings. From among these he had picked out several characteristic crystals.

JANUARY 8.

Mr. GEO. Y. SHOEMAKER in the chair.

Ten persons present.

A paper entitled "Some Phenomena in the Life-History of Clathrulina elegans," by Miss S. G. Foulke, was presented for publication.

Visual Organs of Lamellibranchs.—Dr. BENJAMIN SHARP reported on his work on the lamellibranch eye. He had examined the edge of the mantle of *Ostrea virginica* and *Mitilis edulis* of the Asiphonata, and the siphons of *Venus mercenaria*, *Mya arenaria*, *Mactra solidissima*, besides the forms already described for *Solen ensis* and *S. vagina* (Proc. of Academy of Nat. Sciences of Phila., 1883, pp. 248–9). The pigmented cells found in these parts are essentially the same as those found in *Solen ensis* and *S. vagina*. The smallest of all the cells were found in *Ostrea* and the largest in *Venus*. Experiments on these forms show their sensitiveness to light and shadow, and the cells showing the retinal character described leaves little doubt as to the power of vision. No nerves could be demonstrated passing direct to these cells, and probably those distributed to the general epidermis serve in transmitting the impressions. The visual power is so low that nerves have not been yet specialized for this purpose.

JANUARY 15.

The President, Dr. LEIDY, in the chair.

Twenty persons present.

A Phosphorescent Variety of Limestone.—Professor LEWIS gave a description of a remarkable substance found in one of the mountain mines of Utah, near Salt Lake City, sent to him some months ago by Professor Cope. It is a white rock which phosphoresces with a lurid red light whenever struck or scratched with a hard substance, and on that account has been called by the miners, *Hell-fire rock*.

It proves upon examination to be an almost perfectly pure carbonate of lime, containing occasionally slight impurities of iron, etc. It is a loose grained, white, crystalline limestone, the grains of which are but slightly coherent, giving the rock the appearance of a soft sandstone. Upon slight abrasion in the hand, it crumbles to form a coarse, calcareous sand. Under the microscope the rock appears as a loose mass of irregular, angular grains, which are nearly transparent, and which have a lustre resembling that of alum. Portions of the rock are colored slightly yellow by oxide of iron.

Its phosphorescent properties are very remarkable, entitling it to rank as a new variety of limestone. It was long ago noticed by Becquerel that some limestones were slightly phosphorescent after heating or insolation, but so far as known, no other limestone possesses this property in a degree at all approaching that

now described, the phosphorescence of which is nearly as strong as that of fluor spar.

Phosphorescence is developed when the rock is either struck, scratched or heated. Upon using metal, glass or any other hard substance to strike or to scratch it, a deep red light is emitted, which continues sometimes for several seconds after the blow. Rubbing with other fragments or grinding in a mortar developed a white light. The most remarkable phosphorescence is developed by heating a fragment of the limestone in a glass tube over a flame. It then glows with a deep red light which lasts for a minute or more after withdrawing the flame. The color of the light emitted resembles that of a red-hot body. Several seconds before dying out, the light becomes white or bluish white. Upon cooling and subsequent heating, phosphorescence is again developed in the same fragment, but much more feebly and for a shorter period, and after two or three such heatings, its phosphorescence is destroyed.

Experiments made by the speaker upon the temperature at which "Hell-fire rock" became phosphorescent, showed that phosphorescence occurred at a temperature somewhat under 500° F. Small fragments phosphoresced much more quickly than large ones. The lurid red light produced by a blow from a hammer varied in duration of visibility according to the strength of the blow. The phosphorescence produced by a slight touch lasted only half a second, while a sharp blow produced a light which remained more than twenty seconds after the blow was given. Doubtless, a blow with a miner's pick upon the rock would cause still longer phosphorescence.

It was found that the phosphorescence developed by heating occurred nearly contemporaneously with the decrepitation of the calcite, and this fact may be of value in theoretical considerations.

A search through the collection of the Academy for limestones having similar properties resulted in finding a limestone from Kaghberry, India, which glowed with a strong yellow phosphorescent light when heated. No phosphorescence was produced by friction alone, as in the case of the Utah limestone. It was of great interest to find that this Indian limestone, and this one alone of all in the collection, had the precise external characters of that from Utah. It had the same crystalline structure and state of aggregation, crumbling readily in the fingers, and resembling a sandstone. It was labeled "Phosphorescent Sandstone," although containing no siliceous sand.

This similarity of external characters between the two phosphorescent limestones is certainly more than a coincidence. It confirms Becquerel's view that phosphorescence depends upon physical rather than chemical conditions. He has shown that when Aragonite is calcined, fused with sulphur and then heated, it phosphoresces with a green light; whereas calcite, similarly

treated, gives a yellow light; from which he concludes that the different colors depend upon different crystalline states, the composition remaining the same.

The speaker had been fortunate enough to observe the rare phenomenon of the phosphorescence of snow, having seen a snow-covered Alpine mountain shining at night as though illuminated by moonlight. This beautiful appearance lasted for about half an hour only, and was confined to a single mountain. Here again the phosphorescence, although of quite a different kind from either of those mentioned above, was purely physical, depending upon the assumption of a certain crystalline condition of the snow.

In general, the phosphorescence of a substance may be said to depend upon an alteration in its molecular state of aggregation. In the case of "Hell-fire rock" it appears to be the result of a disturbance of its loosely aggregated crystalline particles, whether such disturbance be produced by percussion, friction, heat or decrepitation.

The New Jersey Coast after the storm of Jan. 8, 1884.—Professor Leidy stated that, in company with Dr. Sharp and Mr. Ford, he had made a trip to Atlantic City, N. J., to observe the result of the recent storm on the marine animals of our coast. The shore at the highest line reached by the tides was for miles covered with incalculable numbers of the Beach-clam, *Mactra solidissima*. These in many places formed extensive patches actually closely paved with the clams. Besides those visible, it is probable as many or more were covered by the sand thrown up with the clams. Until this evidence of the storm, he had no suspicion that the mollusk was so exceedingly abundant on the coast, though he had been well aware that it was very common, and had repeatedly seen large quantities thrown on shore under similar circumstances. With the Mactra were other mollusks, and, though numerous enough, they appeared to be few compared with the former. These were *Fulgur carica* and *F. canaliculata*, *Natica heros* and *N. duplicata*, and *Nassa obsoleta*. Hermit crabs were also numerous, *Eupagurus pollicaris* in shells of Natica and Fulgur, and *E. longicarpus* in shells of Nassa. The former shells had attached abundance of *Crepidula unguiformis*, and occasionally on the outside a *C. fornicata*. Of other crabs, the Spider-crab, *Libinia canaliculata* and *Platyonichus ocellatus* were frequent. A few half-grown Horse-shoe crabs, *Limulus polyphemus*, were also observed. A few bunches of *Mytilus edulis* were occasionally met with.

It seemed remarkable that certain common mollusks were conspicuously absent, as the Oyster, *Ostrea virginiana*, the Clam, *Venus mercenaria*, the Squirt-clam, *Mya arenaria*, and the Horse mussel, *Modiola plicatula*. Scarcely any annelides were observed,

except masses of dead *Serpula* invested with *Eschara variabilis*. There were also no echinoderms, except one, the *Caudina arenata*, which occurred in some places in considerable numbers. This, it was believed, is the first time the animal has been observed on the coast of New Jersey. The specimens presented were collected by Mr. Ford. They usually range from three to four or five inches in length; but several were upwards of six inches, and over an inch at the thicker portion of the body.

It is an interesting question as to what becomes of the vast quantities of *Mactra* and other shells incessantly cast on shore. Storms annually oblige the ocean to contribute from its inexhaustible stores, multitudes of mollusks and other animals to the sandy beach. By exposure to the influence of the weather, the air, the sun, the rain, frosts and other violence, the calcareous shells are broken and decomposed, and in a comparatively few years entirely disappear. Carbonic acid, of the rain-water, must be a potent agent in their ultimate solution as it percolates through the sands. While the beach receives its constant supplies of shells, no trace of these is to be found in the sands immediately back of the shore; which sands in former times received the same incessant contributions. For similar reasons, no doubt, calcareous fossils are comparatively rare in sandstones, though in many cases their impressions are well preserved.

Flora of North America.—At the meeting of the Botanical Section of the Academy, held on January 14, Dr. Asa Gray spoke of the progress of the forthcoming portion of the Synoptical Flora of North America, and of the occasions which had led to the publication of the middle portions in advance of the earlier. It had seemed important now to secure the results of the many years of study which he had given to the large and difficult order of Compositæ, which will form the bulk of the forthcoming part. He spoke of the perplexities attendant upon the accurate definition of generic divisions in this order, and especially of properly discriminating the species of such genera as *Aster* and *Solidago*. He had no idea that he had really solved the difficulties of this kind, or that any one would entirely solve them; but he had done his best. He could himself name the species of *Solidago*, and he could name a good many Asters; but he doubted whether he had enabled other botanists to name them. Being asked whether his views respecting the limitation of species had not undergone some change, in the direction of admitting more species now than formerly, he admitted that this was probably the case. He still held to what might be termed the Linnæan conception of species, that they were to be taken in a broad sense and expected to comprise various forms, which might or might not be classified into varieties. But whereas, in his younger days, species were thought to be independent creations, and the real differences,

if we could find them, supposed to be absolute, we now look upon allied species as having descended from a common ancient stock, of which intermediate forms have died out, and therefore do not expect that allied forms, on the whole distinct and definable, should be completely unconnected by certain links or vestiges of links. Moreover, it used to be thought that hybrids were necessarily sterile, but it is now known that some hybrids are fertile, and that their offspring, fertilized by either parent, are generally fertile; that in this way intermediate forms between two species may originate; and it is clear that the two species ought not to be reduced to one on account of such intermediate forms. Dr. Gray referred to *Rosa*, *Rubus* and *Hieracium*, in the Old World, as genera in which no two botanists who had studied them could agree as to what were species; one school reducing them to very few, which they can define only by disregarding certain intermediate forms; the other multiplying them by hundreds, and characterizing them by distinctions which might serve for the specimens in hand, but which failed with every new collection. This necessitated either the formation of a still finer-drawn set of species, or the falling back to the broader Linnæan conception of a species. The latter alternative had been generally followed in this country, and Dr. Gray hoped that the coming American botanists would incline to this view in the treatment of our critical genera.

Relation of Medullary Rays to the Strength of Timber.—Dr. ROTHROCK called attention to some experiments made by Mr. Frank Day, in the laboratory of the University of Penna., on the relation of the medullary ray to the strength of timber. Mr. Day had found that it required just about twice as much force (say 1130 pounds) to pull apart a square inch of live oak, if the force ran parallel to these rays as if the force were applied at right-angles to them.

What is true of the live oak was also largely true of other timbers. The buttonwood (*Platanus occidentalis*) was remarkable for the development of its medullary rays, and also for the difficulty in splitting that wood at right-angles to them.

Mr. Day's experiments also proved that there existed great differences in the quality of the material of the woody fibre; for in timber where the relative proportion of wood and ducts could well be compared, and where the fibres were of equal size throughout, differences in strength were to be found.

Botanical Notes. Double Flowers in Gelsemium nitidum; Euonymus Japonicus; Development of Fruit of Opuntia; Helianthus tuberosus; Carya glabra.—Mr. MEEHAN exhibited two specimens of double flowers of *Gelsemium nitidum*, one found wild in Georgia, the other in Alabama. One was straw-colored, the other deep yellow. He remarked that many double flowers in

gardens, credited to the florists' skill, were wildlings which had been taken into cultivation.

Mr. Meehan also remarked that *Euonymus radicans*, under culture from Japan, is believed by some modern botanists to be but a variety of *E. Japonicus*. He exhibited branches of the latter which had been produced by the former. They were not varieties, but simply frutescent and radicant forms of each other.

The speaker exhibited specimens of *Opuntia frutescens*, var. *longispina*, in which fruit had formed, though no flowers had appeared, the scarcely developed sepals and petals having been thrown off the apex in infancy. A regular gradation from perfect branches to these fruits was exhibited, some of those most closely related to perfectly formed fruit having a tendency to the red coloring which marked the fruits. Occasion was taken to emphasize the morphological doctrine, that fruits like apples and pears are but arrested branches.

In continuation, Mr. Meehan reintroduced specimens exhibited at a former meeting, showing that the roots of a supposed Jerusalem artichoke, wild near Philadelphia, and supposed to have been in some past time an escape from gardens, had characteristics somewhat different from the form now under culture in the vicinity, and inquired whether this might be what has been hitherto known as *Helianthus doronocoides*, which Dr. Gray had demonstrated some years ago in Silliman's Journal, to be the parent of *H. tuberosus*. If so, it might prove that this species was indigenous to Eastern Pennsylvania.

Dr. Asa Gray did not think the species was indigenous here. He rather suspected that the form now wild had once been the cultivated one, and that the ones now in use had been introduced since. He remarked that he had been working among the roots of different species of the genus, during the past autumn, some of which he found had merely fleshy roots, like those of *Dahlia*, making no runners; others had runners developed into true tubers.

Mr. Meehan also exhibited some nuts of *Carya glabra* Torr. (*C. porcina* Nutt.) which had been brought in by one of his seed collectors from a tree in the woods in the vicinity of Philadelphia. They had two or sometimes three nuts in a single exocarp, as in the manner of *Castanea vesca*, the common chestnut. The collector was under the impression that all the nuts borne by the tree were of a similar character.

Dr. Asa Gray remarked that this occurrence of two or three nuts of *Carya* within the same husk, either separate or partly coherent, was of much morphological significance. Specimens like these had been sent to him several years ago, said to have been collected in Montgomery Co., Penna., with the remark that the tree bore a good many such abnormal fruits; Dr. Gray believed that the conclusion to which they inevitably pointed had

not yet been published. It was, however, communicated to Dr. Engelmann, along with a portion of his specimens, at least five years ago. The conclusion drawn was the following: The husk, or so-called exocarp, of *Carya*, is an *involucre*, usually containing a single female flower, and connate with its ovary; its true morphology is revealed when, as in this case, it contains two or three flowers. The stone or shell of the nut is the whole pericarp in *Carya* as much as in *Corylus*. In the former genus it becomes free from the four-valved involucre at maturity; in *Juglans* the congenital union is more permanent, forming a drupaceous accessory fruit, of which the fleshy part is involucre, the bony part is pericarp. This view directly homologizes the *Juglandaceæ* with the *Cupuliferæ*.

The following was ordered to be printed :—

SOME PHENOMENA IN THE LIFE-HISTORY OF CLATHRULINA ELEGANS.

BY SARA GWENDOLEN FOULKE.

While collecting infusoria among *Lemna* and the leaves of the yellow pond-lily, in a ditch on Brandywine Creek, Chester county, Pennsylvania, the writer was so fortunate as to secure large numbers of that beautiful Heliozoan, *Clathrulina elegans.*

This rhizopod was attached in myriads to the roots of the *Lemna*, the groups in many cases being composed of above twenty-five colony-stocks, so matted together by the twisting of the pedicels, and so surrounded by waste matter, as completely to conceal at that point the supporting root-fibre.

The animals were in a most active condition, feeding by means of their characteristic pseudopodial rays, and multiplying so freely by self-division, that the water was full of the Actinophrys-like bodies, and almost every capsule supported from one to ten young individuals.

After being kept in captivity for two weeks, the large social groups had decreased in number, although solitary individuals were much more numerous. Reproduction was still going on, but not so freely, and by more varied methods. The phenomena exhibited during the act of reproduction are the subject of this communication.

The modes of reproduction are four in number, two of these being slightly similar, while the others essentially differ in character. These four modes are: *first*, by division; *second*, by the instantaneous throwing off of a small mass of sarcode; *third*, by the transformation of the body into flagellate monads; and *fourth*, by the formation and liberation of minute germs. By the *first* mode, and this is the most common, the sarcode mass within the capsule withdraws its rays, constricts, and divides into from two to four granular masses, which, after a varying period of rest, pass out from the capsule and instantly shoot forth pseudopodial rays on all sides, thus assuming the appearance of an *Actinophrys sol.* These Actinophrys-like bodies after a time develop a protoplasmic stalk, or pedicel, by which they attach themselves, usually to the parent capsule. A thin film of protoplasm is then thrown out and subtended by the rays, at a short distance from the body, and this, by development and secretion,

becomes the latticed siliceous capsule. The pedicel also becomes more rigid, though always retaining a degree of flexibleness. This manner of reproduction was first described by Cienkowski, the great Russian observer, and discoverer of *Clathrulina elegans* (see Leidy's Rhizopods of North America).

In the *second* mode of reproduction, the rays are not withdrawn, nor does the body divide, but the sarcode becomes finally vacuolate, presenting knob-like projections. Suddenly a small mass of sarcode, usually one of the knob-like projections, detaches itself, and, passing out of the capsule, shoots out rays and develops, though more slowly, in the manner described above. This continues until the parent body is much reduced in size, when the rays again protrude and the animal returns to its normal condition.

The *third* mode of reproduction is by the formation and liberation of minute germs. In this state, also, the rays are not withdrawn, but the body of the *Clathrulina* becomes filled with minute green particles, which, even before liberation, exhibit active motion. A number of these are expelled, enclosed in a thin protoplasmic film or globular sac, which bursts shortly, and the liberated germs swim away. The development of these germs, after this point, is yet to be followed.

The *fourth* mode is still more remarkable, and is also significant in bringing to light a new phase in the life-history of the Heliozoa. The *Clathrulina* in which these phenomena were first observed, withdrew its rays and divided into four parts, as in the ordinary method ; but the sarcode, instead of becoming granular and of a rough surface, grew smoother and more transparent. Then followed a period of quiescence ;—in this case of five or six hours duration, although in other instances lasting three days and nights; after which one of the four parts began slowly to emerge from the capsule, a second following a few moments later.

While passing through the capsule, these masses of sarcode seemed to be of a thicker consistence than the similar bodies, which, in the ordinary method, instantly assume the Actinophrys form. After both had passed completely through, for nearly a minute they lay quiet, gradually elongating meanwhile. Then a tremor became visible at one end, and a short prolongation of the sarcode appeared waving to and fro. This elongated at the same time into a flagellum, the vibrations becoming more rapid, until at the same moment both the liberated monads darted away through the water. They were followed for about ten

minutes, when both were lost to sight among a mass of sediment, and the fear of mistaking one of the common monads for them led the observer to abandon the search. Returning to the parent capsule, a third monad was found to have escaped in the meantime. After twenty-four minutes quiescence, the fourth body in its turn approached the wall of the capsule, emerged, developed a flagellum, and swam away, a free monad. With a one-half inch objective this one was closely watched, and the following details noted: body oval, transparent; nucleus present, dark-colored and situated near the centre; a pulsating pink vesicle, situated posteriorly; and a flagellum slightly longer than the body.

For one hour and fifty-eight minutes the monad swam in all directions, usually in concentric, ever widening circles, then suddenly darting off at a tangent to begin again in a new spot. At the end of this time, in its course it touched one of the free young *Clathrulina*, and, to prevent it being used as food by its cannibal relation, the glass cover of the live-box was tapped, so that the current produced carried the monad a short distance away, where it remained almost motionless several seconds.

By a change to a power of three hundred and fifty diameters, the monad was shown to attach the top of its flagellum to the glass and revolve swiftly for a few moments, when instantly the whole body became spherical, rays were shot out, and the transformed monad was in no point, except that of size, to be distinguished from its Actinophrys-like cousin, whose career had been so different. In some cases the monads remained attached by the flagellum, using it as a pedicel. The whole development, from the time when the monad began its free life, occupied two hours and some seconds.

This mode of reproduction secures a more widespread distribution of the young than would be possible did this depend on the sluggish Actinophrys form. It seems reasonable to suppose that this is a wise provision for the perpetuation of the species, should adverse conditions of life arise; and also to prevent an undue accumulation of the animals within a circumscribed space.

The tendency of these rhizopods to attach themselves to the parent capsule, a result of the inertness of the Actinophrys form of young; together with the fact that this mode of reproduction was apparently induced by a lengthened captivity, necessarily the source of adverse conditions, would point to the reasonableness of the above conclusions.

JANUARY 22.

The President, Dr. LEIDY, in the chair.

Twenty-eight persons present.

The death of James C. Hand, a member, was announced.

A paper entitled "On Semper's Method of Making Dried Preparations," by Dr. Benj. Sharp, was presented for publication.

Indian Mounds on the Miami River.—Mr. F. W. PUTNAM, Curator of the Peabody Museum of American Archæology and Ethnology, Cambridge, Mass., gave an account of the explorations now in progress by himself and Dr. C. L. Metz, of an interesting group of earthworks in the Little Miami valley. It consists of twelve mounds enclosed by an embankment of earth which runs across the lowland and connects by a graded way with a circular embankment on a hill thirty feet high, within which are two other mounds. The mounds have proved to be very important, as several are constructed in a peculiar manner. In two of the mounds circular stone walls were found, and from these walls stones have been laid, covering in the central portions of the mounds. Several of the mounds were stratified, and contained basins, or "altars," of burnt clay, upon which were thousands of objects more or less injured by fire. Burnt human remains were found in several of the mounds, and in others were skeletons, showing that both methods of disposing of the dead were resorted to. Many interesting objects were found with the skeletons. The most important discoveries were made on the "altars," which contained, among other things, many works of art, including small terra-cotta figures representing men and women, carved stone dishes in the form of animals, and various objects cut from mica, among them a serpent and a grotesque human face.

There were also found a large number of objects made of native copper, and several of native or meteoric iron. This is the first time that native iron has been found in the mounds. Several copper ornaments were covered with silver, and a few fragments of a thin sheet of hammered native gold were also obtained. Over fifty thousand pearls were found on one of the altars, with thousands of other ornaments made of bone, shell, and the teeth of animals. Among the latter were large canine teeth of bears, which may prove to be those of the grizzly bear, or some species larger than the black bear. Several chipped points of obsidian and a number of singular pendants made in a peculiar manner from a micaceous schist, were on one of the altars.

Another important discovery was mentioned as having just been made, but not yet worked out. This consisted of a series

of large pits, six or seven feet deep, in the natural clay below the burnt clay layer of one of the mounds. These pits had long clay tubes, or flues, extending from them, and there is some evidence that these pits were used as places of cremation, but this must be determined by further and careful study. A number of photographs were exhibited, illustrating the structure of the mounds and the objects found in them.

Note on Manayunkia speciosa.—Mr. EDW. POTTS reported having found specimens of *Manayunkia speciosa* Leidy, amongst material collected in the Schuylkill River, above Fairmount dam; thus determining what had previously admitted of a shade of doubt, the strictly fresh-water habitat of this species. In continuation he narrated some points within his own observation, supplementary to Dr. Leidy's description.

The branchial organs (tentacles) appeared to him to be grouped upon two processes on each of the lateral lophophores, eight each in the upper or more dorsal groups, and six or possibly more in each of the others. Beside these, there is a single pair placed centrally upon the dorsal portion of the head, and a similar pair opposite, which do not seem to be connected with either of these groups. The whole number is therefore 32–36. The alternating contractions and dilatations of the vessels conveying the green blood through the dorsal pair above mentioned are very conspicuous.

While the general appearance of this crown of tentacles, when expanded, is somewhat similar to that of a polyzoan, there is a noticeable difference in the effect produced by the motion of their cilia. In the latter a powerful *incurrent* bears food particles, etc., towards the mouth as a vortex; in the former case, while the motion draws these particles from without or behind the circle towards the tentacles, the moment they pass between them they are influenced by an *excurrent* bearing them forcibly away. This outflowing current is further shown by the fact that excrementitious matters are drawn rapidly forward through the tube, and ejected at its anterior extremity.

As food, therefore, cannot be sucked into the mouth of the worm, we find that it is carried in. Acceptable particles which touch the tentacles are grasped by the cilia, and rapidly passed down amongst them in near contact with the tentacle into grooves at the base of the above-mentioned processes, and thence into the digestive tract.

Beside the specimens above mentioned from the Schuylkill River, Mr. Potts has had recently under observation a considerable number, say fifteen or twenty, from the pond near Absecom. One of these, to which most of his time had been devoted, had been kept for many days isolated in a microscopic stage tank. While in this situation it, for some reason, left its old tube and formed another, giving him the opportunity to observe the

character of the latter, and the method of its construction. In its earliest stages it is a transparent, smooth, and homogeneous slime-like excretion, within which the worm may be very clearly seen, as it works its way forward or drags itself backward by means of its podal hooks and spines. Later on, the anterior extremity thickens and becomes more and more opaque, and, as Dr. Leidy has observed, "feebly annulated," presumably from the adherence of effete particles, and their compression by the repeated withdrawal of the ciliated tentacles into the mouth of the tube. This method of prolongation must continue during the residence of the worm, and in consequence, if supported, it may sometimes reach a length which is several times that of its inhabitant.

JANUARY 29.

The President, Dr. LEIDY, in the chair.

Thirty-three persons present.

Fossil Bones from Louisiana.—Prof. LEIDY directed attention to a collection of fossil bones, which have been submitted to his examination by the Smithsonian Institution. They were obtained by Mr. William Crooks, at the mine of the American Salt Company, near New Iberia, La. They chiefly consist of remains of *Mastodon americanus*, of *Equus major*, of *Equus*, not distinguishable from those of the domestic horse, and of *Mylodon harlani*. Of *Mastodon* the collection contained well preserved molar teeth, and characteristic fragments of bones. Of the *Equus major*, there are vertebræ, fragments of long bones, and a number of teeth. The molars are characterized by their comparatively large size and complexity of arrangement in the enamel folding, especially of the upper molars. Of *Mylodon* there are several molar teeth, vertebræ and other bones, mostly fragments. Among the bones are two mature and well-preserved tibiæ, the best specimens yet discovered of the species. They are identical in form and size with those of *M. robustus*; indicating *M. harlani* to have been a species of the same size as the former. The extreme length of the tibia internally is nine inches; breadth across the head, seven inches; across the distal extremity, five and one-half inches. Further collections were anticipated from the same locality.

Foraminifera in the Drift of Minnesota.—Prof. LEIDY stated that he had recently received for examination, from Mr. B. W. Thomas, of Chicago, several glass slips with mounted specimens of sand. These were obtained by washing clay from the boulder drift of Meeker Co., Minnesota. In the specimens, Prof. Leidy

recognized some well-preserved and characteristic foraminifera, of which two forms appeared identical with *Textularia globulosa* and *Rotalia globulosa*, now living in the Atlantic Ocean. The fossils Mr. Thomas supposes to be derived from a soft yellow rock, cretaceous shale and lignite, forming part of the drift. He also reports the finding of fragments of marine diatomes in the clay.

The following were elected members :—

Benjamin R. Smith, Rev. Wayland Hoyt, Wm. Thomson, M.D., H. W. Stelwagon, M. D., John Struthers, D. G. Brinton, M. D., Thomas H. Fenton, M. D., and Miss Helen Abbott.

The following were elected correspondents :—

Karl A. Zittel, of Munich; Marquis de Gaston de Saporto, of Aix; Quintino Sella, of Rome; August Daubrie, of Paris; and Albert Gaudry, of Paris.

The following was ordered to be printed :—

ON SEMPER'S METHOD OF MAKING DRIED PREPARATIONS.

BY DR. BENJAMIN SHARP.

Although this admirable method has been known and published for a number of years, it does not seem to have met with general acceptance. Many persons, indeed, with whom I have spoken do not seem to know of it at all, and for that reason I do not think it amiss to give an account of it here.

I have had the pleasure of working under Professor C. Semper, the discoverer of this method, for two years, and have seen, as well as prepared, many specimens. I have seen some specimens that have been prepared by this method over ten years ago, and not the slightest change has taken place in them, and they look as beautiful as those just finished.

The method requires close attention at certain stages, and the result depends upon the amount of care bestowed; the end, when successful, fully repays any amount of care that has been taken.

Nearly any animal or animal tissue may be prepared by this method; some require naturally more care than others—of fish, where there is a large quantity of fatty substance present, the greatest care is to be taken.

Dissections of animals are especially adapted for this method, and most of Prof. Semper's preparations are in this form. If desirable, when finished, the different systems of organs may be colored and thus serve as beautiful specimens for demonstration.

The object to be prepared is first placed in a solution of chromic acid of about $\frac{1}{4}$ to $\frac{1}{2}$ per cent., or even 1 per cent. In the case of dissections, these are to be prepared after the animal is killed and then placed in a dissecting tray, the bottom of which is filled with wax, so that different parts may be pinned out and thus better exposed to view; the tray may be then filled with the chromic acid solution.

The size and consistency of the object determines the length of time that it should remain in the solution; Annelides, small Gastropoda or Lamellibranchiata, small organs, as kidneys, etc., or small vertebrates, as frogs, mice, birds, etc., should remain in from six to eight hours; larger animals or organs from eight to twenty-four.

The chromic acid is merely to kill the tissues, and at the same

time hardens them somewhat. Any other of the hardening fluids may be used, and for these I can refer the reader to Dr. C. O. Whitman's paper on this subject, which appeared in the *American Naturalist*, (vol. xvi, 1882, pp. 697, 772). Chromic acid, however, is the reagent that Prof. Semper always uses, and it seems to answer every purpose.

After the object has been left a sufficient length of time in the fluid, this is poured off and the vessel filled with water, which should be constantly changed until there is no yellow color either in the object or in the water. In other words, as much of the acid must be withdrawn as possible. This part of the process is considerably shortened by allowing a current of water to flow through the vessel. This stage takes from ten to twenty hours, or even more.

After this is completed the object is placed in weak alcohol, from 30 to 40 per cent., for at least a day; when the specimen is quite small, ten or fifteen hours are sufficient. Then the alcohol may be strengthened to 60 or 70 per cent., and the object remain in this for two or three days (with larger objects, a week).

The object may now be placed in strong alcohol, from 90 to 95 per cent., for about the same length of time as with the 70 per cent. It may, indeed, remain here for weeks or months. I have often taken specimens that had been well preserved, after having been for a year in 90 per cent. alcohol, with as good a result as if freshly prepared.

In cases of dissections where parts have been pinned apart, after passing through the 70 per cent. alcohol stage, they may be taken carefully out of the trays, and the rest of the process gone through with in closely stopped bottles, for they are at this point quite stiff.

When objects have remained a sufficient length of time in the strong alcohol, they are placed in absolute alcohol. If the strong alcohol be changed once or twice, it will necessarily save the absolute alcohol to some extent.

This stage of absolute alcohol is the most critical part of the whole process. *Absolutely* every particle of the water must be removed, and the secret of the whole success depends on this one point. If any water be left in the tissue, it will become spotted and eventually spoil. I feel positive that those who have tried this method and have failed to produce satisfactory results, have

not been careful enough to remove every particle of water. I always take the precaution of changing the absolute alcohol once or twice, especially in moist climates.

After *all* the water has been withdrawn by the absolute alcohol, by remaining in it for three days to a week, the object is placed in turpentine, the best that can be procured. In this it is allowed to remain until it becomes thoroughly saturated—with large objects it is best to change the turpentine once. Two or three days are required for this stage. When saturated the object is quite stiff, and when the process is successful little or no contraction has taken place. The object is then placed in the air and protected carefully from the dust, and the turpentine allowed to evaporate. The object then soon presents a very beautiful appearance; it becomes white, resembling the whitest kid. It is light, stiff and, on account of the resin it contains, is perfectly insect-proof.

In annelides the iridescence is perfectly kept; hair and feathers retain their original colors.

If hollow organs, as the stomach, bladders, lungs, etc., are to be prepared, they may be blown up after they have been a short time in the turpentine; by so doing much space, and consequently much alcohol, are saved.

This is the practical part of the method, and I may add in a few words the whole principle. The object is to carefully and slowly harden the tissue and to *remove every particle of water*, the place of which is taken by the resin.

If the process be hurried contractions are apt to occur, and consequently bad-looking specimens result.

The *advantages* of this method are great. We have a perfectly dry object, with the perfect form kept; it is far preferable to handle than alcoholic dissections or preparations. It will last indefinitely and is insect-proof.

Prof. Semper keeps his preparations in glass boxes which are perfectly dust-proof, and by this both sides of the preparation can be distinctly seen.

An addition to this process was discovered by Prof. Semper about two years ago, which I do not think has yet been published. It is to place the prepared object in a solution of glycerine and sugar. In some objects this brings back almost entirely the original color of the animal; one disadvantage of this is, however,

that unless kept in dust-proof cases they would become spoiled by the dust collecting on them.

As absolute alcohol is so expensive in this country, the cost of a large specimen would be considerable, and therefore the process is better adapted for smaller objects.

A cheap method of making absolute alcohol, from the strong (95 per cent.) spirit, used in Prof. L. Rauvier's laboratory in Paris, would not, I think, be out of place to be mentioned here.

The details of this process were given me by my friend, Dr. W. Vignal, the assistant of Prof. Rauvier. A wide-mouthed bottle is taken, holding about a litre, and a three-quarters filled with the strong alcohol.

A mass of pulverized cupric sulphate ($CuSO_4 + 5$ Aq.) is heated to a red heat in order to drive off the water of crystallization. This is poured, when cool, into the alcohol, the mouth of the bottle quickly closed, and the whole shaken. The cupric sulphate is insoluble in alcohol, but has an affinity for the water contained in it, and the water is consequently taken up, and the cupric sulphate becomes bluish. When this has stood—with occasional shakings—for a day or so, decant, and repeat the operation, especially if there is very much of a blue color in the sediment.

When finished a drop of alcohol can be mixed with a drop of turpentine on an object-glass, and if there be no particles of water to be seen under the microscope, the alcohol is absolute enough for all practical purposes.

FEBRUARY 5.

The President, Dr. LEIDY, in the chair.

Twenty-seven persons present.

The following papers were presented for publication :—

"Notes on a Collection of Anchovies from Havana and Key West, with an account of a new species, Stolephorus eurystole, from Wood's Holl, Mass.," by Jos. Swain and Seth E. Meek.

"On a new species of Rotifer, of the Genus Apsilus," by Sara Gwendolen Foulke.

The death of Wm. T. Haines, a member, was announced.

FEBRUARY 12.

Rev. H. C. MCCOOK, D. D., in the chair.

Thirty persons present.

A paper entitled "List of Fishes from Egmont Key, Florida, in the museum of Yale College, with descriptions of two new species," by David S. Jordan, was presented for publication.

Fresh-water Sponges as improbable causes of the pollution of river-water.—Mr. POTTS reported that on the 9th of February he had visited and partially examined the forebay at Fairmount Water-works, on the Schuylkill River, from which the water had been temporarily withdrawn, with a view to discover the winter condition of the fresh-water sponges and the other inhabitants of that locality. He found far the larger part of the wall surface below the water-line inaccessible on account of a thick deposit of mud upon the bottom, and much water remaining in the fore-bay. Wherever reached, however, and so far as the eye could detect in other places, it was covered by a mud-colored incrustation of considerable thickness, which a more minute examination showed to be composed almost wholly of the statoblasts and spicules of the sponge *Meyenia Leidyi*. Some few fragments of *Meyenia fluviatilis* and *Spongilla fragilis* were seen, but the first-named was clearly the prevailing species.

A sluiceway which formerly supplied the last of the old "breast wheels" used in pumping into the reservoir, but from which the water had been for many months excluded, was entered and examined. Here the remaining incrustation (much having doubtless crumbled and fallen away) was from one-fourth to one-half

an inch thick, of the appearance of crumbling plaster, and, as in the other cases, it consisted of the sponge before named, with but a small proportion of intruded material.

While considering the effect of the presence of so large a sponge-growth at the very inlet to the supply-pumps, Mr. Potts stated that this particular species was conspicuous among the known North American sponges by its great relative density and the small proportion of its sarcode or flesh. Its decay, therefore, at the termination of its period of summer growth would be a less cause of pollution to the water-supply than that of any other sponge

Moreover, from recent investigations into the life-history of these low organisms, he was inclined to believe that decay was not the normal or necessary result of the close of each season's growth. The fragile branches of some species inhabiting exposed situations may, of course, be broken off and destroyed while the sarcode still covers them; but in the sessile portions, and in all when sufficiently protected, the cells of the sarcode at the period of full maturity, forsaking their places along the lines of the skeleton framework, gather together by simultaneous amœboid movements into dense groups, where they are soon covered by a tough chitinous "coat," which, in time, generally becomes surrounded by a "crust" of minute granular cells, and armor-plated by a series of protective spicules. These groups are now recognized as the statoblasts, gemmules or winter-eggs of the sponge—eggs only in appearance—in reality the resting spores or protected germs which conserve the life of the individual through the cold and storms of winter, and awake very early in the springtime into new life—yet a continuance only of the same existence which was seen a few months before nestling into this winter's sleep.

If this is the ordinary course with these organisms there seems no reason to regard them as serious causes of the pollution of our streams, though violent freshets before this resting period is reached may tear them to pieces, and their decay may give a temporary taint to the water.

Continuing the narrative of his exploration, Mr. Potts described the iron pipes which had lain for many years upon the bottom of the fore-bay, as covered in some places to the depth of an inch or more, with a crust richly colored by iron-oxide, but principally composed, as were the others, of the spicules and statoblasts of *M. Leidyi*. Upon the surface of this crust in places, he found the remains of large colonies of *Urnatella gracilis* Leidy. In the absence of any positive knowledge of the winter condition of this curious polyp, Mr. Potts had examined with much interest a novel form of statoblast, which was frequent upon the same pieces of sponge; but he was unsuccessful in associating it with the polyzoan. It is most probable that the life is continued as suggested by Dr. Leidy, within the urn-like joints of this crea-

ture, and that they put out buds and a new growth in the spring. To discover if this be the case he had placed some fragments in water, and while awaiting results he had been surprised at the appearance within a few days amongst the fragments of *Urnatella*, of numbers of the recently described chætobranch-worm, *Manayunkia speciosa*, of Leidy, as well as several living cells of a species of *Paludicella*, probably *P. elongata*, of the same author. The persistence and tenacity of life in these apparently delicate creatures, overcoming not only the severity of a hard winter, but an exposure of several days in the open air, were further commented upon.

February 19.

The President, Dr. Leidy, in the chair.

Thirty-seven members present.

The deaths of Dr. Geo. Engelmann and Prof. Arnold Guyot, correspondents, were announced.

Indian use of Apocynum cannabinum as a textile fibre.—At the meeting of the Botanical Section held on the 18th inst., Mr. Thomas Meehan stated that while it was well known that the fibre of *Apocynum cannabinum* was used by the Eastern Indians in the manufacture of baskets, mats and other articles, he had heard it doubted whether the same plant was used by the Indians in the West. He had interested a lady in Washoe Valley, Western Nevada, to get direct from the Indians of that section stems of the plant used by them. She had done so, and he now exhibited them. They proved to be the same plant, *Apocynum cannabinum*.

The Longevity of Trees.—Professor Sheafer, of Pottsville, Pa., reading an abstract of Mr. Meehan's remarks, in Proceedings of the Academy, had cut and sent for the inspection of members some specimens from Schuylkill county, remarkable for slow growth, of a black oak, *Quercus tinctoria*, in which the annual growths showed in a little over two inches from the centre an average of 36 circles to an inch; one of hemlock spruce, *Abies Canadensis*, 51 to an inch; and one of the common chestnut, *Castanea vesca Americana*, 24 to an inch. Though only four inches in diameter, the oak stem was seventy-six years old; the hemlock one hundred and four years and in diameter four inches; and the chestnut four and a half inches in diameter in sixty years.

With a struggle for life either from poverty of the soil, elevation, or close growth of trees, which the small annual growths

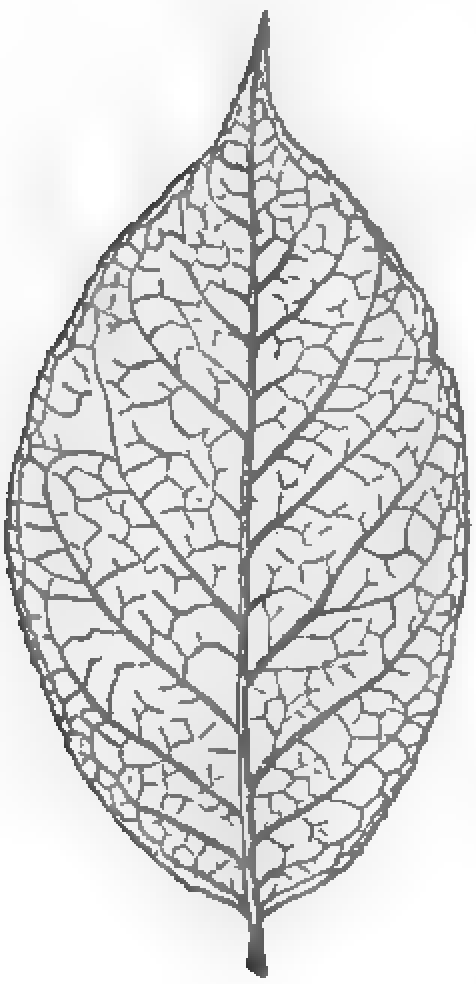
indicated, Mr. Meehan believed the atmospheric conditions, as regards shelter from wind or from drying atmospheric currents, must be very favorable to induce longevity under such circumstances. There seemed to be no reason why these trees might not reach the full average duration of two hundred years, which he had before named as about the duration of most trees of the Eastern United States.

Prof. Sheafer gave some instances indicating that the average might be higher than the figures he had offered.

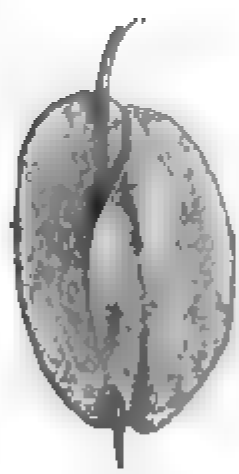
Parasitism in Boschniakia glabra, E. Meyer.—Mr. MEEHAN exhibited a specimen of this Orobanchiaceous plant collected by him last summer, growing among alders in the track of the retreating Davidson Glacier, near Pyramid Harbor, lat. 59°, in Alaska, and remarked that the life-histories of this class of parasitic plants were but imperfectly known, and every new fact of interest. In the Yosemite Valley last year, with Mr. John M. Hutchings and Dr. Charles Shäffer, of the Academy, they had carefully dug out masses of earth with the snow plant of the Sierras, *Sarcodes sanguinea*, and then tenderly washed out every particle of earth in a stream near by. There was not the slightest sign of attachment to any root, and no root of anything to be found in the mass of earth. There were not even the slightest remains of any dead vegetation which could suggest that the plant was even a saprophyte, as was generally found in the case of *Monotropa uniflora*. There was nothing but a huge mass of coralline fleshy matter, out of which the inflorescence rose. The origin of this fleshy mass was yet the unsolved mystery. From analogy with the behavior of other plants, he was inclined to believe that there was some parasitic attachment in the early life of the plant, and that it stored up in this coralline mass enough nutrition in one season to support the inflorescence of another, and, after this was done, severed the connection, leaving no trace by the time the mass was large enough to support the heavy drain of the large and juicy inflorescence. In *Boschniakia*, something of this sort had evidently taken place. The plants were in an early flowering stage, and all, when drawn out of the ground, had a single thread-like root depending from the centre of the pseudo-bulbous base of the plant, as in the specimen exhibited. These threads, now hard and wood-like, broke off very easily at the time, and it did not occur to the collector that they might be alder roots, as the density of the substance might now suggest. The desire to botanize over as large a tract as possible in the six hours given by the commander of the ship, did not admit of time to dig down and ascertain directly whether these threads were alder roots, and in direct connection with the living alder plants; but it would be remarkable, if they should be alder roots, and the *Boschniakia* sessile on them, that the plants should all select roots of the same slender size, and so nearly

exactly alike as the twelve or eighteen specimens examined in this way indicated. Mr. Meehan stated that he had, in his *Flowers and Ferns of the United States*, series ii, vol. ii, p. 95, noted the existence of a similar thready attachment at the base of *Epiphegus Virginiana*, evidently connecting the plant with a foster-parent in early life—a fact since confirmed by Mr. Fergus, of West Chester, Pa.; and a fuller examination of these cases might afford the clue to all.

Variation in Halesia.—Mr. MEEHAN exhibited dry leaves and fruit of *Halesia diptera*, *H. tetraptera*, and of a remarkable departure raised from the last-named species some years ago. This appeared in a bed of seedlings all raised from seed gathered from one tree growing in a garden in Germantown. It attracted attention when one year old by the leaves bearing a resemblance to those of an apple-tree. The parent tree had leaves narrowly lanceolate and acuminate, rather thin, pale green on the upper surface, and with no particularly prominent veins. The plant in question had broadly ovate leaves, scarcely pointed, very dark green and rugose on the upper surface, and strongly veined and hirsute below. It was planted to see what it would come to.



1. *H. tetraptera.*

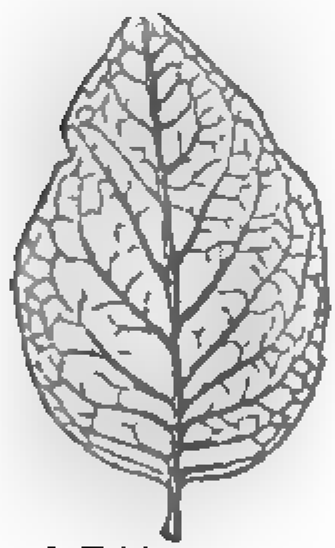


1*a*. *H. tetraptera.*

The flowers were open cup-shaped, instead of being drawn into a narrow tube at the base, as in the parent plant and the pistil was wholly enclosed and not exserted. For several years the plant was sterile, and many good botanists, whose attention was called to it, regarded the plant as a hybrid, and the sterility as a proof thereof. It seemed of no avail to point out that there was no other species with which the parent could have obtained pollen within many miles, nor to show that hybrids were not necessarily sterile. This season the plant produced fruit for the first time, some of which were now exhibited to the Academy. They are very small, not much over a quarter of an inch in diameter, and the four equal wings were comparatively large and of a strongly coriaceous character. The fruit which had been cut

open were found to have perfect seeds. If the plant with these leaves, flowers and fruit had been found in a state of nature, the botanist would surely have made a new species of it, if indeed he would not have had some doubts of a new genus.

Mr. Meehan then referred to his contributions in the past, tending to show that there was an innate tendency in plants to vary; that this natural tendency was at the foundation of all theories of evolution, and that environment had not near the influence on variation some good botanists claimed for it. If we were to take environment as a serious element of change, there would be no certainty in the direction of change; but a glance at the palæontological and other evidences showed that change had been always in the direction of certain uniform lines, and evidently in accord with a predetermined plan, which the accidents of environment had not been able to override. At any rate, such illustrations as this of the *Halesia* showed a remarkable change with which certainly environment had nothing to do. The seeds were all from one tree, with not even another individual of its own species near it. The seedlings all came up in one bed together, and yet out of many hundred seedlings, all with the same exact conditions of environment, there was not one with even an approach to the singular peculiarities of this.



2. *H. tetraptera*, var.

2a. *H. tetraptera*, var.

In regard to the sterility or fertility of plants, what we would call environment had evidently much to do, and this also he had endeavored to point out in former botanical contributions. In his paper before the American Association for the Advancement of Science, at Detroit, in 1875, he had shown that Mr. Darwin's experiments in keeping bees from clover, and which in England led to sterility, did not so prove in Philadelphia, the protected plants there being fertile; and he there made the suggestion that the different conditions of environment led to the different results. He had also since then shown that *Linum perenne* in Philadelphia was self-fertile, though in England Mr. Darwin had found that one might as well apply so much inorganic dust to a pistil as the flower's own pollen. Here we have another illustration. The exuberance of vegetative growth being checked by age, or some other circumstance of climate or season, acting against the vegetative and in favor of the reproductive principles—principles we know by many illustrations were antagonistic—gave us this season an environment for the first time favorable to fertility.

The figures are two-thirds the actual size.

The following were ordered to be published:—

NOTES ON A COLLECTION OF ANCHOVIES FROM HAVANA AND KEY WEST, WITH AN ACCOUNT OF A NEW SPECIES (STOLEPHORUS EURYSTOLE) FROM WOOD'S HOLL, MASS.

BY JOSEPH SWAIN AND SETH E. MEEK.

The present paper is based on a large collection of Anchovies, made by Professor Jordan at Havana, Cuba, and at Key West, Fla. We recognize two species of *Stolephorus* in this collection from Havana. Both of these species occur in the collection from Key West, as also *Stolephorus miarchus*, a species hitherto recorded only from Mazatlan and Panama on the Pacific Coast.

We are indebted to Professor Jordan for the use of his library and for valuable suggestions.

1. **Stolephorus perfasciatus** (Poey) Swain and Meek.

Engraulis perfasciatus Poey, Memorias Cuba, ii, 313, 1858 (Havana); Poey, Syn. Pisc. Cuba, 421, 1868 (Havana) (not of Poey, Synopsis, p. 460); Günther, Cat. Fishes Brit. Mus., vii, 391 (Cuba) (not of Swain, Bull. U. S. Fish Comm., 1882, 55, nor of Jor. and Gilb., Syn. Fish. N. A., 273).

Head 4 to 4½ in length to base of caudal. Depth 5¾ to 6½. Dorsal 12 to 13. Anal 14 to 16.

Body oblong, somewhat compressed. Snout shorter than eye, compressed and painted. Top of head with a slight keel. Eye about 3½ in head. Mouth slightly oblique. Maxillary and lower jaw finely toothed. The posterior end of maxillary rounded, not extending quite to margin of preopercle. Gill-rakers numerous, rather weak and toothed on under side, the longest about 1⅓ in eye. Pectoral fins about 1¾ in head, their tips not reaching ventrals by about diameter of eye. Ventrals short, their tips not reaching anal by length of fin. Caudal forked. Origin of anal below last ray of dorsal. Origin of dorsal midway between root of caudal and pupil. Scales deciduous. Color as in *Stolephorus browni*, without dark punctulations except on base of caudal and often on base of anal. Sides with a well-defined silvery band, its width about ¾ eye, being rather narrower than usual in *S. browni*.

This description is taken from numerous well-preserved specimens, about 2¼ inches in length, obtained by Prof. Jordan with

a seine at Key West. Five specimens, the largest about 3 inches in length, were also obtained at Havana.

Stolephorus perfasciatus Jordan and Gilbert, Syn. Fishes North America, p. 273, and Swain, Bull. U. S. Fish Comm., 1882, p. 55, is a different species, apparently without a name. It differs chiefly in a greater number of anal rays, and in having a wider and less silvery lateral band. No specimen of the true *perfasciatus* is known to reach the size of the specimen from Wood's Holl, Mass. This species from Wood's Holl may stand as *Stolephorus eurystole* Swain and Meek. Specimens of this species, perhaps mixed with others, have been distributed by the U. S. National Museum under the following numbers, 19,003 to 19.017. The one originally described by Mr. Swain and by Jordan and Gilbert was destroyed in the burning of the Museum of the Indiana University, but others like it exist in the U. S. National Museum.

2. **Stolephorus browni** (Gmelin) Jordan and Gilbert.

This species is by far the most common of the Anchovies, both at Key West and Havana. For synonymy and description see Swain, Bull. U. S. Fish Comm., 1882, 56. *Engraulis perfasciatus* Poey, Syn. Pisc. Cuba, 1868, 460, is apparently not a true *perfasciatus*, and is probably this species.

3. **Stolephorus miarchus** Jordan and Gilbert.

Stolephorus miarchus Jordan and Gilbert, Proceed. U. S. Nat. Mus., 1881, 334 (Mazatlan).

Four specimens from Key West. We are unable to detect any discrepancy between these specimens and the descriptions published by Jordan and Gilbert of the types of this species from Mazatlan.

4. **Cetengraulis brevis** (Poey) Swain and Meek.

Engraulis brevis Poey, Repert. Fis. Nat. Cuba, i, 379, 1866 (Cuba); Poey, Syn. Pisc. Cuba, 422, 1868 (Cuba); Günther, Cat. Fishes Brit. Mus., vii, 383, 1868 (no specimen).

Head in length to base of caudal, $3\frac{1}{2}$ ($4\frac{1}{8}$ in total); greatest depth 3 ($3\frac{2}{5}$); about 40 scales in lateral line, and 11 scales in a transverse series beginning at origin of anal fin. Anal 23 to 25. Dorsal 15.

Body deep, compressed; belly compressed, not serrate. Head rather short. Snout short and sharply pointed, $1\frac{1}{3}$ in eye, which

equals the width of interorbital area and is contained 4 times in the length of head.

Mouth somewhat oblique; mandible extending little in front of anterior part of orbit. Maxillary slender, very finely toothed on posterior two-thirds only, not quite reaching root of mandible. Lower jaw toothless. Gill-rakers close-set, longer than diameter of eye, 3½ in head. Cheeks triangular, longer than high.

Scales rather firm, not caducous. Pectoral fin not reaching base of ventral, 2 in head. Ventrals short, 3 in head. Caudal deeply forked, minutely scaled, 1½ in head. Base of anal contained 1⅗ times in head. Dorsal and anal fins with dense basal sheaths, which entirely hide the fin when depressed.

Color in spirits plain silvery on sides, darker above. A dark band beneath the scales about as broad as eye, extending from upper angle of opercle to caudal.

This description is based on specimens about 4½ inches in length, obtained by Prof. Jordan in the Havana Market.

ON A NEW SPECIES OF ROTIFER, OF THE GENUS APSILUS.

BY SARA GWENDOLEN FOULKE.

Among *Spirogyra* and *Anacharis*, gathered in Fairmount Park, were noticed numbers of large rotifers, attached to filaments and leaves of the plants. Though resembling in some respects the forms, *Dictyophora*, of Leidy; *Apsilus*, of Meczinchow, and *Cupelopagus*, of Forbes, this rotifer still possesses sufficiently striking differences to warrant its being regarded as a distinct species. The size of the specimens examined varied greatly, the maximum size being one-fiftieth of an inch, from the top of the extended net to the end of the body.

The ventral outline of the body is ovoid; the lateral outline is crescent-shaped; while the dorsal outline is similar to the ventral. Instead of rotatory organs, this rotifer possesses a membraneous cup or net, near the base of which, on the ventral side, are two lateral antennæ, as in *Apsilus lentiformis*.

When the net is retracted, the antennæ are also withdrawn into the body, and concealed from view. This is an unusual habit among the Rotatoria, the antennæ being usually situated upon the body, and remaining exposed so as to act as sentinels when the rotatory organs are retracted. This net is used for the capture of food, consisting of the larger infusoria closing over any organism which is attracted into it. After capture, the food passes through the oral aperture into a large, sac-like passage-way, and thence into a second pouch, which extends across the body in the form of a much-wrinkled bag. The two ends of this bag widen into sacculated pouches, which are used as storehouses for the food while softening. This organ may be regarded as the stomach proper, being filled with a greenish granular fluid, which performs the office of a true gastric juice, softening the tissues of the contained food, in preparation for the action of the mastax. When this maceration has been sufficiently prolonged, the food is forced, by muscular contraction, out of its recess, along the narrow central portion, past the mastax and into the opposite pouch. As the stream of food passes, the mastax, which is situated centrally at the bottom of the stomach, turns, so as to face the stream of mingled food and gastric fluid; and works actively, chopping and bruising such portions as come

within reach. The mastax exactly resembles that of the three other known species, being composed of two curved major unci, near the base of each of which are situated four minor unci. After being acted upon by the mastax, the food passes between the unci into the œsophagus whence it is absorbed or thrown off by the system. The ventral view of these organs is usually obscured by large numbers of embryo, in various stages of development. In front of the digestive sac, and apparently connected with it, are two curved, pear-shaped sacs, of a transparent greenish hue.

This rotifer, in common with all members of its genus, has an unarticulated body, which is incapable of contraction.

The net, which takes the place of rotatory organs, is shaped like a hood, the ventral portion being elevated into an obtuse lobe. In order to strengthen and support the long, curved, dorsal outline of the net, there is, covering about two-thirds of it, a membraneous shield, made doubly strong by two wide, arched, muscular bands running around it. At the base of this shield is a pointed projection, which is of still firmer composition. The necessity for such an arrangement is obvious, when it is remembered that the normal position of the animal is a semi-recumbent one; so that the weight of the net, which is about three-quarters the area of the body, would be very considerable at these carefully strengthened points.

The whole muscular system of this species is strongly marked and powerful. Focussing downwards from the outside of the dorsal view of the net, two gradually narrowing ridges or flaps are seen extending up the inside of the hood. These flaps are fringed with quite long cilia, and there are also shorter diagonal lines of more minute cilia, the exact number of which lines could not be accurately determined. This is the first instance in which cilia have been discovered in any member of the genus, all those species previously described, being stated to be *totally destitute* of these organs. In this case, their presence was first detected while focussing through the dorsal side of the net, although they could afterwards be plainly seen in a ventral view. It was only by careful placing of the mirror that the cilia were visible.

Attached to the inside walls of the rotifer were the enigmatical transparent bodies common in the Rotatoria; and also a number

of purplish brown bodies, varying in intensity of tint, whose character is as yet unknown.

The rotifer, in the adult state, is tailless, eyeless, and attached in a semi-recumbent position, from which it is incapable of detaching itself, and without the power of re-attaching itself when displaced.

In the young state it has two red eye-spots; a clumsy telescopic tail, terminating in a broad, cup-shaped sucker; and is so actively free swimming that no accurate drawing could be obtained. In this undeveloped state the rudimentary net is a thick fleshy triangle, the truncated apex of which is inserted into the body, while the base is surrounded by a wreath of cilia, on the closed space within which the eye-spots are set. There is in this stage no opening to admit nourishment.

The development of this form into that of the very dissimilar adult state is most interesting, and well worth the time and patience necessary to observe it.

It is proposed to unite the three forms, *Dictyophora vorax*, *Apsilus lentiformis*, *Cupelopagus bucinedax*, and the form described above, in one genus under the name *Apsilus*. The name *Dictyophora* would have the first claim for adoption, but it is already in use in two other branches of science, so that the choice must fall upon the next in order of priority. The specific names given to the forms by their discoverers are retained. The history of the genus is as follows: In 1857, Dr. Jos. Leidy discovered and described a form which he named *Dictyophora vorax*. In 1866, Meczinchow described and named a similar form which he named *Apsilus lentiformis*, the differences from *Dictyophora* being as follows: shape of the cup; presence of two lateral antennæ; and presence of a conspicuous ganglion of the pouch. In 1882, S. A. Forbes described a form which he named *Cupelopagus bucinedax*, designating it as a new genus. The differences between this and the two forms previously described are as follows: *Cupelopagus* differs from *Dictyophora* in the shape of the net, and in the general shape of the body, the difference in these particulars being very marked. It differs from *Apsilus* in the absence of the ganglion of the pouch, in the absence of the lateral antennæ, and in other minor particulars.

The species described by the author varies from the foregoing in the following respects: it differs from *Dictyophora* in the

shape of the cup, as well as that of the body; in the presence of two lateral antennæ; in the possession of a second crop or stomach situated below the ordinary crop; in the marked muscular system, and in the ciliation of the net.

The points of dissimilarity between this form and *Apsilus* are as follows: The shape of the cup; the absence of the ganglion; the presence of a second stomach, and in the ciliation of the cup. It differs from *Cupelopagus*: in the shape of the cup; in the construction of the cup; in the two lateral antennæ; in the presence of a secondary stomach; and in the ciliation of the net.

The presence of the secondary stomach distinguishes this species from the rest of the genus. The presence of cilia is not so certain a distinction, as by dexterous management of illumination their presence might possibly be detected in some other of the species.

From the presence of the secondary stomach or pouch, it is proposed to name this new species *Apsilus bipera*—*pera* meaning "a little pouch to carry food."

The reasons for uniting the three forms heretofore considered separate genera, are, of course, founded on the strong points of resemblance; these being, briefly, the presence of two eye-spots, of a membraneous cup, of a mastax exactly similar in all four forms, of the absence of tail or footstalk, of the absence of carapace, and of the similar habits.

The characteristics heretofore used in the classification of the Rotatoria, as denoting members of the same genus, are: character of rotatory organs; number of eye-spots; absence or presence of carapace, and habits.

In selecting the name for this new division, *Dictyophora*, of Leidy, has the right of priority, but, owing to its having been already many years in use, in two other branches of science, the choice must fall upon that next in order of priority, which is *Apsilus*, of Meczinchow.

The genus *Apsilus*, then, will consist of four species—*Apsilus vorax* Leidy; *Apsilus lentiformis* Meczinchow; *Apsilus bucinedax* Forbes; and *Apsilus bipera* Foulke.

As there is no family in the class Rotatoria, in which the above genus may be placed, a new family, to be named *Apsilidæ*, is pro-

posed; characteristic, the substitution of a membraneous cup or net, destitute of external ciliation, in the place of the ordinary rotatory organs.

Bibliog.—Leidy, *Proc. Acad. Nat. Sci.*, 1857, 204; Meczinchow, *Zeits. f. wis. Zoologie*, 1866, 346, *Taf. XIX;* Forbes, *Am. Month. Micros. Jour.*, 1882, 102, 151.

REFERENCES TO PLATE I.

FIG. 1. *Apsilus vorax* (*Dictyophora vorax* of Leidy). *a.* Membraneous net. *b.* Crop. *c, c.* Embryo. *d.* Mastax. *e.* Œsophagus. *f.* Oral aperture. *g.* Vent. *h.* Muscular system of net. *Reduced from drawing by Leidy. The body is slightly wider in proportion to the net than in original drawing.*

FIG. 2. *Apsilus lentiformis* Meczinchow. *a, a.* Antennæ. *b.* Muscular system of net. *c.* Crop. *d.* Mastax. *e, e.* Embryo. *f.* Œsophagus. *g.* Purplish brown bodies. *Reduced from drawing by Meczinchow.*

FIG. 3. *Apsilus bucinedax* (*Cupelopagus bucinedax* of Forbes). *a.* Net. *b.* Oral aperture. *c.* Crop. *d.* Mastax. *e, e.* Embryo. *f.* Œsophagus. *Reduced from drawing by Forbes.*

FIG. 4. *Apsilus bipera* Foulke. *a, a.* Antennæ. *b.* Muscular system of net. *c.* Oral aperture. *d.* Crop. *e.* Secondary sacculated stomach. *f.* Mastax. *g.* Œsophagus. *h, h.* Embryo. *i.* Enigmatical purplish brown bodies attached to walls of body.

FIG. 5. *Apsilus lentiformis* Meczinchow. *a, a.* Ganglion of the pouch. Superficial view when closed.

FIG. 6. Dorsal view of net of *Apsilus lentiformis*. *a, a, a, a.* Muscular system.

FIG. 7. Dorsal view of net of *Apsilus bipera*. *a.* Shield. *b.* Pointed support. *c.* Portion of net above shield. *d.* Muscular system of shield. *e.* Ciliated flaps extending up inside of net.

LIST OF FISHES FROM EGMONT KEY, FLORIDA, IN THE MUSEUM OF YALE COLLEGE, WITH DESCRIPTION OF TWO NEW SPECIES.

BY DAVID S. JORDAN.

A small collection of fishes from Egmont Key, in Tampa Bay, Southern Florida, belonging to the Museum of Yale College, has been sent to me for identification by Professor A. E. Verrill. The fishes were collected some years ago, a part by Mr. William F. Coons, the remainder by Mr. E. Jewett. In the following list the species collected by Mr. Jewett are marked with the initial "J". Those not thus marked were obtained by Mr. Coons. The numbers given are those on the register of the Museum of Yale College. Those marked with a star (*) have been presented to the Museum of Indiana University.

1. **Rhinobatus lentiginosus** Garman. (805, 821*.)

An adult specimen and a fœtus.

2. **Opisthonema oglinum** (Le Sueur) Bean. (809.)

(*Opisthonema thrissa* Auct., not *Clupea thrissa* L.)

The original type of *Clupea thrissa* L. was a fish brought from China by Lagerstrom and described by Linnæus' pupil Odhel, in the Amœn. Academ., v, 251, under the name (prebinomial) of *Clupea thryza*. Lagerstrom's fish was a species of *Dorosoma*. The *Clupea thrissa* of Osbeck was also a *Dorosoma*. In the synonymy given by Linnæus, of *Clupea thrissa*, in the tenth edition of the Systema Naturæ, are included, among others, some references to our *Opisthonema*. In this twelfth edition of the same work is a description of a *Clupea thrissa* received from Dr. Garden of Charleston. This "*thrissa*" is *Dorosoma cepedianum*. The species called *Clupea thrissa* by Broussonet, Cuvier and most later authors, is our *Opisthonema*, but the specific name *thrissa* can be properly used only for the Chinese *Dorosoma*, for which it was at first intended. The oldest name belonging to our species (as already noted by Dr. Bean, Mss.) is that of *Megalops oglina* Le Sueur.

3. **Sidera ocellata** (Agassiz) J. and G. (804; 824* [J]; 840.)

4. **Cœcula scuticaris** (Goode and Bean) J. and G. (800*; 801.)

Head 9½ in distance to vent; trunk very slightly shorter than tail; cleft of mouth 3½ in head, in a specimen 16½ inches long.

Pectorals very minute. This specimen agrees equally well with the description of *Cæcula scuticaris* and *Cæcula teres*, nor is it evident, from the published accounts, how the two are to be distinguished from each other.

5. **Cæcula bascanium** sp. nov. (826 [J.].)

This species belongs to the same group as *Cæcula scuticaris* and *C. teres*, but is distinguished from either by the shorter head and better developed pectoral fin. The type is 31 inches long, in fair condition.

Body extremely slender, subterete, its greatest depth little more than two-fifths length of head; head short; snout short, 7 times in head; mouth very small; lower jaw thin, included, not extending forward to the anterior nostril, which is in a short tube; teeth short, subconic, bluntish, a little unequal; their points directed backward; lower teeth nearly in one series; upper teeth uniserial laterally, partly biserial anteriorly; vomerine teeth in a rhombic patch, some of them a little enlarged. Eye moderate, its length rather more than half snout, its centre scarcely behind middle of upper jaw. Cleft of mouth $3\frac{3}{4}$ in length of head. Gill-opening vertical, about as wide as isthmus, its upper edge about on level of upper edge of pectoral; pectoral small, but larger than in related species, a little broader than long and about as long as snout. Dorsal fin very low, beginning at a point about midway between front of eye and gill-opening; anal similar to dorsal. Head $11\frac{1}{2}$ times in distance from snout to vent. Trunk a little longer than tail. Total length 31 inches; head $1\frac{3}{8}$ inches; trunk $14\frac{7}{8}$; tail $14\frac{1}{2}$. Color in spirits, dark-brown, nearly or quite uniform; fins paler.

6. **Ophichthys intertinctus** (Richardson) Günther. (803*; 825 [J].)

Dark brown above, paler below; sides and back with about three rows of large, ovate, brown spots, somewhat irregular in size and position, those of the upper row smallest, the large and small ones of the lower row somewhat alternating; spots on head small and numerous. Dorsal with an interrupted dark margin; anal with a darker edge; pectorals blackish. Head $3\frac{1}{2}$ in trunk; cleft of mouth nearly half length of head; pectoral about 5 in head. Dorsal commencing a little behind end of pectoral. Tail rather longer than rest of body. The dentition is well described by Dr. Günther (viii, 57).

Two large specimens. This species has not been previously recorded from the waters of the United States.

7. **Myrophis egmontis** sp. nov. (802; 827* [J.].)

Two specimens in fair condition.

Head small, slender, moderately pointed; anterior nostril in a short tube; posterior nostril large, with a raised rim, placed directly behind the anterior; cleft of mouth rather short, extending to beyond the rather large eye, which is more than half the length of the snout; cleft of mouth $3\frac{1}{3}$ in head; teeth in both jaws subequal, pointed, slightly compressed, arranged in single series, those of both jaws directed backward, the lower teeth being more oblique than the upper; upper jaw with about 4 small fixed canines. No teeth on vomer in either of the typical specimens. Tongue not free. Lower jaw considerably shorter than upper, its edge considerably curved, concave in profile. Nape somewhat elevated. Top of head with large pores.

Head $5\frac{1}{2}$ times in distance from snout to vent; head and trunk a little shorter than tail. Body slender, its greatest depth a little more than length of gape. Pectoral fin short and broad, slightly longer than snout; gill-opening short, oblique, extending downward and backward from near the middle of the base of the pectoral. Dorsal fin beginning behind vent, in one specimen at a distance about equal to length of gape; in the other specimen, a little farther forward; dorsal fin very low in front, becoming gradually higher toward the tip of tail; anal fin low, but well developed, considerably higher than dorsal, highest anteriorly, uniting with the dorsal around the tail.

Color in spirits, dark-brown, apparently uniform, somewhat paler below.

Length of specimen about 15 inches.

We refer this species to *Myrophis*, although its dorsal is inserted very much farther back than in any of the known species of that genus. The absence of vomerine teeth, if normal, still farther separates it from the other species, and it is not unlikely that it should be regarded as the type of a distinct genus.

One of the types (827) has been presented to the U. S. National Museum.

8. **Siphostoma affine** (Günther) Jordan. (839* [3].)

9. **Stromateus alepidotus** (L.) Jor. and Gilb. (812.)

The adoption of the earlier name, *Stromateus paru* L., for this species is perhaps premature, until West Indian specimens are examined.

10. **Trachynotus carolinus** (L.) Gill. (810.)

11. **Lutjanus campechianus** Poey. (842* [2].)

12. **Chætodipterus faber** (Broussonet) J. and G. (811.)

13. **Batrachus pardus** Goode and Bean. (823 [J].)

One specimen, with the typical coloration of this form.

14. **Gobiesox virgatulus** Jordan and Gilbert. (838 [3].)

Three specimens; the largest rather more than three inches long, thus much larger than the original types. Caudal dusky; a dusky blotch on front of dorsal, D. 11, A. 8. Eyes very small, barely one-fourth interorbital width. Head 3; its width 2½. Lower teeth moderate, entire; upper bluntish, in two or three rows, two of the outer a little enlarged. This is probably identical with *Gobiesox nudus* Günther, but it cannot be the original *Cyclopterus nudus* of L.

15. **Scorpæna stearnsi** Goode and Bean. (806.)

16. **Achirus brachialis** Bean. (843.)

A very young example, brown with a few irregular large whitish spots.

17. **Aphoristia plagiusa** (L.) Jor. and Gilb. (843.)

A very young specimen.

18. **Malthe vespertilio** L., var. *radiata* Mitch. (795.)

A short-nosed individual of the type which has been called *Malthe cubifrons* Rich, and *Lophius radiatus* Mitchill.

19. **Antennarius ocellatus** (Bloch and Schneider) Poey. (796*; 797; 822 [J].)

Pescador Parra, Peces de Cuba, Pl. 1, 1787.

Lophius vespertilio, var. *d*, *ocellatus* Bloch and Schneider, Ichth., 1801, 142.

Antennarius pleurophthalmus Gill., Proc. Ac. Nat. Sci. Phila., 1863, 92.

Color in spirits, brown; pale on the head and belly, darker posteriorly; anterior region covered with small, sharply defined black spots; the spots posteriorly larger, and more vague in outline, some of them diffuse shades; fins spotted like the body; vertical fins with some paler spots also, and a pale edge;

sides of body also with irregular gray leprous blotches (perhaps pink in life), the largest between last dorsal spine and first dorsal ray, forming a saddle; numerous smaller areas below this to base of pectoral; some on head; a small saddle between second and third dorsal spines; a large ring of the same grayish color, behind dorsal, forming a ring about caudal peduncle; some other blotches between soft dorsal and anal; a ring of black dots about eye; a large oblong black spot on middle of base of soft dorsal, surrounded by a light brownish ring; a similar ocellus below and a little before this on side of body, and a third on caudal fin a little before and above its centre; a few whitish dermal flaps on soft dorsal; inside of mouth black, with broad whitish longitudinal stripes, these most distinct on the tongue. Third dorsal spine much longer than second, its length equal to its distance from tip of snout; length of maxillary 4½ in body. Upper part of head with some coarse, four-rooted stellar tubercles.

Our specimens agree very closely with the description of Dr. Gill. There can, however, be little doubt of their identity with with the *Pescador* of Parra, on which the *Lophius ocellatus* of Bloch and Schneider was based. The characteristic position of the ocellated spots is precisely the same in the two. I therefore adopt for it the name *ocellatus*. It is not improbable that *Antennarius annulatus* Gill, from Garden Key, will be found identical with *A. multiocellatus* (Cuv. and Val.).

20. **Balistes carolinensis** Gmelin. (805.)

21. **Alutera schœpfi** (Walbaum) Goode and Bean. (834.)

22. **Diodon liturosus** Shaw. (815.)

A young specimen, apparently corresponding to Dr. Günther's var. *a*, of *Diodon maculatus*.

FEBRUARY 26.

The President, Dr. LEIDY, in the chair.

Twenty persons present.

The following were presented for publication:—

"On an Ammonite from the Carboniferous formation of Texas," by Prof. Angelo Heilprin.

"The Tertiary Geology of Eastern and Southern United States," by Prof. Angelo Heilprin.

Messrs. Geo. W. Fiss and Francis E. Emory were elected members.

Distoma and Filariæ.—Prof. LEIDY directed attention to some parasitic worms presented this evening. Some of these were supposed to be leeches from the mouth of the alligator. Herodotus states that the crocodile of the Nile has the inside of its mouth always beset with leeches. The existence of the leech has been confirmed, and is known as the *Bdella nilotica*. The present specimens, however, do not belong to a leech, but pertain to a species of *Distoma*, apparently not previously described. It may be named and be distinguished by the characters as follows:—

DISTOMA ORICOLA. Body elongated elliptical, moderately wider and thicker posteriorly, and ending in a blunt, angular extremity, convex dorsally and flat ventrally, unarmed, smooth or minutely wrinkled transversely. Mouth subterminal, and enclosed with a reniform lip succeeded by a linear annulus. Acetabulum large, globular, included at the anterior fourth of the body, and opening ventrally by a conspicuous central aperture. Generative orifice ventral, at the posterior fourth of the body. Length, 15 to 20 mm.; breadth, 3 mm. Eight specimens obtained from the mouth of the alligator, *A. mississippiensis*, in Florida, by Mr. Stuart Wood.

Accompanying the specimens is a fragment of the tongue marked with circular scars, apparently due to the worms. The alcoholic specimens in their present condition are incurved, with the lateral margins inverted, and the included acetabulum produces a conspicuous dorsal eminence.

Of several Filariæ exhibited, two, a female and a male, pertain to the species *Filaria horrida*, Diesing. The former is 28 inches long, the latter 11 inches. They were obtained by Dr. Henry C. Chapman, from the thorax of the American ostrich, *Rhea americana*. The other specimens were obtained by Mr. P. L. Jouy, from the abdomen of *Strix brachyotus*. They consist of four females from 12 to 14 inches long and a half a line thick, and two males $2\frac{1}{2}$ inches long and one-fourth of a line thick.

They are thicker anteriorly with the head end obtusely rounded, and with the mouth minute and bounded by a minute pair of conical lips. The tail end of the female is straight and blunt; that of the male is more tapering, and is included in an elliptical alary appendage, supported on each side by a row of five curving ribs. A pair of similar, but shorter and straight papillæ is situated near the anal aperture; and a pair of pointed processes diverge from the end of the tail into the alary expanse.

Two species of Filaria have been previously observed in *Strix brachyotus*, *F. attenuata* Rud., and *F. foveata* Schn., to neither of which the specimens under examination appear to belong. These, however, so closely accord with the descriptions of *F. labiata* Creplin, from the black stork, *Ciconia nigra*, that, notwithstanding the remote relationship in the host, the speaker believed them to belong to that species. In the construction of the caudal extremity of the male, they closely approximate the condition of *F. labiata* and *F. horrida*, as represented in the figures of Schneider (Monographie der Nematoden), while they are widely different from that of *F. attenuata* and *F. foveata*, as represented in similar figures of the same work.

Some notes on Manayunkia speciosa.—Prof. H. Carvill Lewis read a communication from Miss S. G. Foulke, in which the following statements were made:—

In the worm *Manayunkia speciosa*, described and figured by Prof. Leidy (Proc. Acad. Nat. Sci. Phila., 1883), the tentacular crown, or branchial organ, is the feature of special interest.

According to Dr. Leidy, the tentacles present in an adult are eighteen in number, besides two larger and longer tentacles situated midway between the two lophophores. These larger tentacles are conspicuous by their bright green color, and are, in fact, external continuations of the blood-vessels extending lengthwise throughout the body. In shape, these tentacles taper from base to apex, are convex on the outside, but concave on the side which faces the centre of the tentacular crown; so that a transverse section would present the shape of a crescent. The two edges thus formed are fringed with cilia. When closely watched, the green tentacles are seen to pulsate with a rhythmical motion, contracting and expanding longitudinally. The pulsation takes place in each tentacle alternately.

At the moment of contraction the tentacle turns slightly on its axis, outwards and towards the end of the lophophore on that side, at the same time giving a backward jerk, returning to its former position at the moment of expansion.

By force of the contraction, the green blood filling the tentacle is forced downwards out of the tentacle, and flows along the blood-vessel on that side of the body. On the expanding of the tentacle, the blood instantly returns and suffuses it, and thus the process goes on.

The contraction and expansion occur at exact intervals, together occupying the space of two seconds. It is in this way that the blood is purified and its circulation controlled. These observations were made with a seven-eighths inch objective.

To ascertain how long the cilia upon the tentacles would continue their motion after separation from the body of the worm, both lophophores of an adult were cut off above their junction.

At first the tentacles remained closed from the shock, but soon they were expanded, the cilia displaying active motion, and presently the two separated lophophores began to move about in the zoophyte-trough. This motion was produced by the action of the tentacles, which bent in all directions, the tips touching the glass, and was not a result of the currents produced by the cilia. In a few minutes one lophophore had *crawled* in this manner quite across the trough, while the other remained floating in the water near its first position. In the case of this latter the motion was produced by the ciliary currents, and was entirely distinct from the *crawling* above noted.

During this time the decapitated worm had sunk to the bottom, and, though turning and twisting a good deal, did not attempt to protrude the mutilated support of the lophophores. Its body was so much contracted that the segments were not above one-third their usual size.

At the end of five hours the worm was apparently dead, numbers of infusoria had collected to prey upon it, and the surface of the body presented a roughened appearance as though covered with tubercles. The lophophores were still crawling and swimming about.

At the end of the eighth hour the lophophores had ceased to crawl, but the ciliary action, though feeble and uncertain, still continued. The body of the worm was then covered with a thick fungoid growth, consisting of transparent rod-like filaments three-sixteenths of an inch in length; some of the filaments presented a beaded appearance. All motion of the cilia upon the tentacles had ceased, and these also were being devoured by infusoria.

The above experiment shows that the motion of the cilia continued about twice as long as the mutilated worm gave evidence of life.

Several individuals of *Manayunkia* were observed to be preyed upon, while still living, by large monads, embedded in one or more of the segments, which were sometimes excavated to a considerable degree.

MARCH 4.

The President, Dr. LEIDY, in the chair.

Thirty-seven persons present.

A paper entitled "The Rufous or Thatching Ant of Dakota and Colorado," by Henry C. McCook, D. D., was presented for publication.

Dictyophora as Apsilus vorax.—Prof. LEIDY stated that Mr. Uselma C. Smith, last week, had afforded him the opportunity of examining a wheelless rotifer, attributed to *Apsilus*, which he had found abundantly, last autumn, in a pond at Fairmount Park, attached to *Anacharis*, and likewise in the Schuylkill River, near by, on *Potamogeton*. A number of specimens were observed attached to the sides of the jar, as well as to both the plants contained therein. The specimens being more readily detached from the latter than from the glass vessel, they were seen under more favorable circumstances than previously. They were recognized as *Dictyophora*, first described in 1857; and as a result of the last examinations, Prof. Leidy was led to the opinion that this, the *Apsilus lentiformis* Meczinchow, the *Cupelopagus bucinedax* Forbes, and the *Apsilus bipera*, recently communicated to the Academy by Miss Foulke, all pertain to the same species. In the recent specimens he had recognized the lateral antennæ ending in exceedingly delicate and motionless cils, as indicated by Meczinchow, and which previously, from the wrinkled condition of the specimens detached from hard objects, had escaped his attention. The structure described by Meczinchow as a ganglion, he could not satisfactorily distinguish as such; nor had he been able to detect the arrangement of the excretory canals, as represented by the same author. The lateral view of the animal accords with the figure of *Cupelopagus* as given by Forbes; the body being ovoid, with the mouth of the prehensile cup oblique, and appearing more or less unequally two-lipped. In this view the antennæ are undistinguishable. In all the forms described, the prehensile cup, in the same manner, is projected from and withdrawn within the mouth of a compressed oval or nearly spherical carapace, dotted with minute tubercles. The prehensile cup, substituting the usual rotary organs of rotifers, communicates with a capacious, variably sacculated and dilatable stomach, followed by the ordinary gizzard with its mastax, and then a second sacculated stomach. The ovoidal cloacal pouch opens by an aperture, with radiated folds, externally, some distance in advance of the fundus of the carapace.

The size of the different specimens described varies greatly,

but nevertheless appears to gradate between the extremes. The specimens recently examined were the smallest observed; and in the closed condition measured 0·32 to 0·35 mm. long by 0·3 to 0·32 mm. broad. Former ones described were from 0·35 to 0·6 mm. long by 0·28 to 0·5 mm. broad. For *Cupelopagus*, Forbes gives 0·64 mm. long by 0·56 broad; and for *Apsilus lentiformis*, Meczinchow gives 0·8 mm. long by 0·7 mm. broad.

Miss Foulke enquired whether Dr. Leidy had noticed the secondary sacculated stomach.

The President answered in the affirmative, and stated that the secondary stomach was present in all the forms.

Miss Foulke replied that none of the forms previously discovered had been either figured or described as possessing this organ; that Dr. Leidy's description coincided exactly with that of *Apsilus bipera*, as given by the speaker; and that, in any case, should this form, though differing in every particular save the structure of the mastax, prove to be identical with the *Dictyophora vorax* of 1857, still the differences between *Apsilus bipera*, the *Apsilus lentiformis* of Meczinchow and the *Cupelopagus* of Forbes—viz.: the difference in shape, the presence or absence of antennæ, of the secondary stomach, and of the ciliation of the cup—remain the same, and must separate the forms until proof of their identity can be given.

A New Species of Trachelius.—Prof. H. Carvill Lewis, on behalf of Miss S. G. Foulke, made the following communication:

Having poured some Schuylkill water, freshly drawn from the spigot, into a tube, a white speck was noticed swimming freely about. On being placed in a live-box, and examined with a power of thirty-eight diameters, this speck proved to be a member of the family Trachelidæ, of Ehrenberg.

The family Trachelidæ includes three genera:—*Trachelius*, *Amphileptus*, and *Loxophyllum*.

The genus *Trachelius* consists of but one species, *Trachelius ovum* (Ehr.), from which the form found in the Schuylkill water differs considerably in shape.

Trachelius ovum was described by Ehrenberg as possessing a complex and profusely ramified œsophagus canal, and this opinion was endorsed by Lieberkuhn, also by Claparède and Lachmann; but W. Saville Kent disputed the point, and believes the appearance of the above structure to be given by the extreme vacuolation of the protoplasm, which would lend a branched intestine-like appearance to the intervening granular sarcode. The observations of the writer, in this respect, entirely coincide with those of Mr. Kent.

Ehrenberg also placed in the genus *Trachelius* two other species, viz., *T. tricophora* and *T. dendropholus*, but these forms, being true flagellates, have been relegated to the genus *Astasia*.

In appearance, the form now to be described is markedly convex on the dorsal side, but is deeply indented longitudinally on the ventral side. The sarcode is highly vacuolate, the vacuoles narrowing towards the centre of the body. The fluid sarcode is granular, and the surface of the body is covered with a network of circles of various sizes, which, when enlarged three hundred and fifty diameters, are seen to be minute globular vacuoles. The snout-like prolongation, at the base of which is situated the oral aperture, is shorter than is usually represented in *Trachelius ovum.*

The principal difference has regard to shape, *Trachelius ovum* being egg-shaped, as indicated by the name, while the form just described is globosely convex dorsally, but flattened with a deep indentation ventrally.

It is a curious fact, and one whose import is not very complimentary to our water-supply, that the habitat of *Trachelius* is universally given as *bog-water.*

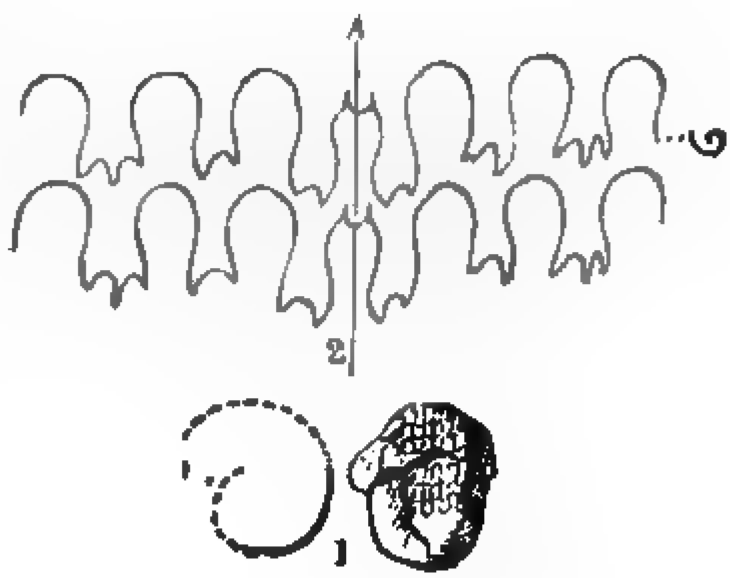
It is proposed to name this new species *Trachelius Leidyi.*

The following was ordered to be printed :—

ON A CARBONIFEROUS AMMONITE FROM TEXAS.

BY PROFESSOR ANGELO HEILPRIN.

Among a limited number of carboniferous fossils obtained from the border of Wise County, Texas, and submitted to me for examination by my friend, Mr. G. Howard Parker, a form occurs which can unhesitatingly be referred to the family *Ammonitidæ*, and to the old genus *Ammonites*. Only a fragment of a single individual of the form in question is to be found, and this, unfortunately, has lost the shell, so that no external ornamentation, if any such existed, can now be detected. What there is of the specimen, however, sufficiently indicates that it was smooth, or destitute of ribs, and that the decidedly globose form was marked by a strong involution of the whorls, which appear almost completely embracing. The umbilical region cannot be clearly made out. The sutural lines of the septa are very clearly defined, and exhibit the ammonitic foliations in very nearly their simplest expression. The lobes and saddles are numerous and closely packed, the general appearance presented by them to the unassisted eye being that of tessellation.



1. Fragments, natural size. 2. Septal sutures, magnified.

The siphonal lobe is considerably the largest, and is split into two prominent tongues by the extension inwards of a deep sinus having approximately the same width as the lateral prongs; the lateral prongs terminate each in two teeth, the inner one of which, counting from the siphonal line, is somewhat longer than the external; the base of the lobal sinus produced anteriorly into two acute sulci. The first lateral lobe terminates in two teeth, the inner or siphonal one the shorter, truncated at the extremity, and sometimes exhibiting indications of apical division;

the second lateral lobes with three teeth, the median one of which is the longest. The saddles are simply rounded, and exhibit, as far as can be seen in the specimen, no traces of crenulation or denticulation along the anterior margin.

This is the first Ammonite, as far as I am aware, that has been detected in any American formation below the mesozoic series. The association with it of characteristic palæozoic forms of life, such as *Zaphrentis*, *Phillipsia*, *Bellerophon*, *Conularia*, *Chonetes*, and *Productus*, leaves no doubt as to its position, and hence we must conclude that here, as well as in India, where Waagen first announced the occurrence of true carboniferous ammonitic forms, the distribution of this highly characteristic group of organisms was not so rigidly defined by the mesozoic line as geologists had been led to conclude. That pre-mesozoic Ammonites will be discovered elsewhere besides in India and Texas there is no reason to doubt; indeed, no assumption could be more illogical than the contrary—and, therefore, the present discovery is in no way specially surprising, and only rather interesting than important. Special interest, however, attaches to this form, as through it and the individuals or fragments of individuals that have been found in the Tejon (Tertiary) rocks of California,[1] we have established in this country the extreme range of the group which it represents.

As to the relationship of the species which I propose to designate *Ammonites Parkeri*, it may be stated that, judged by such characters as the fragment presents, a position must be assigned to it near to *A. antiquus*, Waag., from the Productus-limestone (Salt-Range), of Kufri, India, described and figured in the *Palæontologia Indica* (ser. xiii, pp. 28-9, 1879), of the Geological Survey, and which Waagen refers to the genus *Arcestes* of Suess. A comparison between the septal sutures of our specimen and the Indian one shows a remarkable similarity, indeed, one might almost say identity, existing between the two, the type of structure being practically the same. The principal difference seems to be some very slight and unimportant modification in the lobal denticulations, and the emargination or depression which exists in the saddle, or rather in some of the saddles of the Indian

[1] Heilprin, "On the Age of the Tejon Rocks of California, and the Occurrence of Ammonitic Remains in Tertiary Deposits." Proc. Acad. Nat. Sciences of Philadelphia, July, 1882.

species. The acicular sulci which terminate the sinus in the siphonal or median lobe do not appear in Waagen's drawing, but as this is done on a small scale, the feature in question may have been overlooked. In either case the septal plication is about equally simple or primitive, and indicates a passage by which a transition is effected from the more complicated forms to the still simpler Goniatite. The discussion of the relationship existing between the *A. antiquus* and certain Goniatitic forms described by De Verneuil and Karpinsky from the sandstone of Artinsk, equally applicable in its reference to the American species, is fully set forth by Waagen (*loc. cit.*).

March 11.

The President, Dr. Leidy, in the chair.

Thirty-nine persons present.

The following papers were presented for publication :—

"A Review of the American Species of the Genus Sphyræna," by Seth E. Meek and Robert Newland.

"Catalogue of Plants collected in July, 1883, during an Excursion along the Pacific Coast in Southeastern Alaska," by Thomas Meehan.

The following was ordered to be printed :—

THE RUFOUS OR THATCHING ANT OF DAKOTA AND COLORADO.

BY HENRY C. McCOOK, D. D.

During the autumn of 1883, I had a series of conversations with Mr. B. S. Russell, an intelligent business man, resident at Jamestown, Dakota, concerning a species of ant which inhabits that Territory. At first I was inclined to think that the insect which Mr. Russell described was the Occident ant, especially as the popular name which it bears among the pioneers is the "stinging ant," but further details caused me to suspect that the habits described must be those of *Formica rufa*, whose nests I had observed in various parts of Colorado. I accordingly entered into correspondence with Dr. R. G. De Puy, of Jamestown, who forwarded me specimens which proved to be *Formica rufa*. I also gave him a number of points to be noted, and directions as to how to proceed in studying these points; all of which were followed up with accuracy and intelligence, that covered all my inquiries. The notes which follow I have written out from the observations of the two gentlemen above named, and those made by myself in Colorado.

Locality and Site.—The entire rolling prairie country lying between the Cheyenne and James Rivers (Dakota), is dotted with a vast number of ant-hills, which extend westwardly as far as the Missouri River. Mr. Russell could not say whether they are to be seen in the Red River Valley, which, however, is frequently overflowed. I first met the hills of Rufa on the "Divide," northeastwardly from Colorado Springs. Subsequently I saw them in South Park, and afterward in the vicinity of Leadville. They were scattered here and there throughout the woods and clearings, along the trails and near the diggings, within the limits and suburbs of the "Camp," as the place was then (1879) called, and were struggling with the miners, with varying success, to maintain their little "claims." I was struck by the fact that these persistent creatures had been able to push up their domiciles to such high sites, and to hold them against the rigors of the winter frosts.

Specimens sent me from Iowa Gulch, near Leadville, by Mr. C. O. Shields, were taken from an elevation of 11,300 feet above the level of the sea.

This characteristic the American Rufas have in common with their European congeners; the *F. rufa* of Switzerland, for example, is found as far up the Alps as the line of vegetation, further progress being apparently limited by the lack of vegetable growth rather than by the temperature.[1] They may, therefore, be reckoned, both on this continent and Europe, as among the most hardy of the ant fauna, best adapted to contend with severities of cold.

Exterior Architecture of Mounds.—The ant-hills in Dakota are for the most part conical elevations, somewhat flattened at the top (fig. 1). Some present the peculiarity of a square base, giving the hill the shape of a pyramid, whose apex is rounded (fig. 2). Dr. De Puy's measurements show heights varying from one foot and a half, to eight inches. The slopes of the sides in two cases are twenty-one and twenty-three inches respectively; two diameters measured are two feet, and one foot six inches, respectively; and one mound gave a measurement of ten feet around the base. The mounds, according to Mr. Russell, average from twelve to fifteen inches in height, and about eighteen inches in base diameter. They are separated from each other by interspaces of from twenty to sixty feet, and are scattered over the prairie in groups or "villages." Dr. De Puy says that one may travel miles without seeing ant-hills, and then come upon clusters of them.

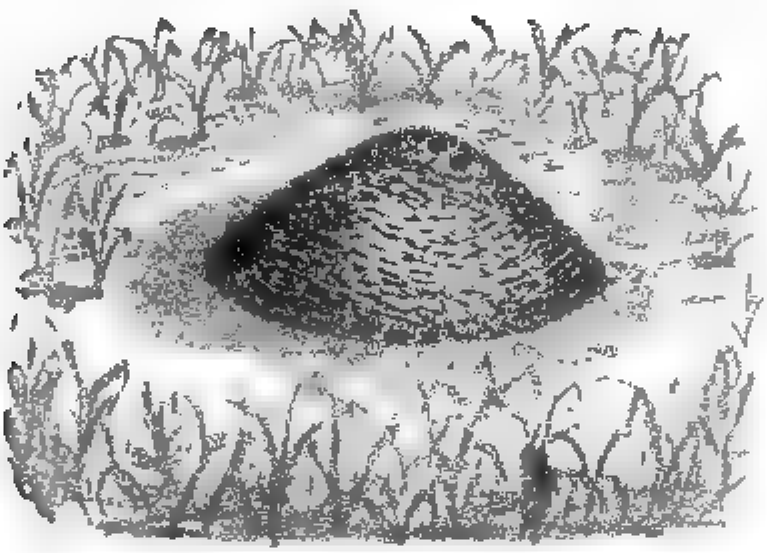


FIG. 1. Conical Mound.—Dakota.

The mounds which I observed in Colorado were chiefly circular elevations of earth, very much flattened at the top (fig. 3). They varied greatly in size, but rarely rose to a greater height than eight inches. One mound observed in South Park and figured, was shaped like a stocking (fig. 4), an odd form certainly, and

[1] *Catalogue des Formicides d'Europe*, by Emory and Forel, p. 450, Mittheilungen der Schweizerischen entomologischen Gesellschaft.

probably caused by the colony pushing up the earth, from two independent centres, which in the course of time united. Future labors might possibly correct this, and round the outlines to their normal shape. I saw one formicary in South Park, which was established under a large stone, along the edges of which the gates or openings were placed. Another was seen on the Divide beyond Colorado Springs, domiciled under an old log in a grove. Here several ant-lions (*Myrmeleon*) had established themselves, cannily digging their pits near the very gates of the formicary, quite in the route of the outcoming and ingoing emmets. The largest mound seen by me, and larger than any reported to me, was found near the summit of the Ute Pass. It was a conical heap, four feet long and about one foot high, and looked like a small haycock.

Thatching the Roofs.—This Ute Pass ant-hill was thickly covered or thatched with bits of wood, fallen needles and broken sprigs of pine, which had been gathered from the forest debris, lying abundantly in the vicinity. All other mounds in South Park and around Leadville were covered in a like manner, with stalks of grass, twigs, and similar rubbish.

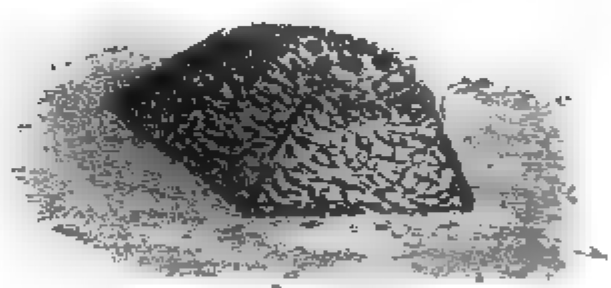


FIG. 2. Mound with Square Base.—Dakota.

The Dakota ant-hills are thatched in precisely the same way, so that one can easily see the propriety of giving the little artisan the popular title of the Thatching ant. As the colony increases its numbers, and the necessity of internal domestic economy requires enlargement of the nurseries, rooms and galleries, the excavated soil is brought up and naturally is laid upon the thatching. In course of time a new roof of chips and clipped grass is overlaid, and thus in the ordinary growth of a mound there would be an alternation of layers of earth and vegetable substance, the latter falling into decay in due season. This theory of the growth of a hill is confirmed by samples of material taken by Dr. De Puy from the interior of the Dakota mounds, which consists of partly decomposed straw, mixed in smaller proportion with soil. The mound-making ants of the Alleghenies (*Formica exsectoïdes*)

have a similar habit of thatching their hills, but this is not as decidedly developed and characteristic as with the Rufous ant; indeed, so far as my observation extends, it is the exception rather than the rule. The thatching habit is possessed by the European representatives of the species (*F. rufa*), in equal degree with those of our Western plains.

Interior Architecture.—I requested Dr. De Puy to open the hills by sawing down through the middle to the surface of the ground, and shoveling away one of the halves. This exposed a section view of the interior, and presented the remarkable feature shown at fig. 5.[1] The central part of the mound, on or about the level of the surface, was found to be occupied by a ball of twigs (B, fig. 5), about eight inches in diameter; the sticks are longer and thicker than those used upon the roof, some of them being two and a half and three inches long. They were found unmixed with soil or any other substance. Several galleries, about one-fourth of an inch in diameter, led upward from this billet-globe to the surface, having their outlet by circular openings (G) through the thatch. The openings, as seen by Dr. De Puy, were usually near the summit and never more than three in number. In Colorado mounds the openings were spread over the top, and were more numerous. Beneath the faggot-ball a series of galleries, seven in number, extended downward to at least the distance of four and a half feet, the extent of the excavation made by Dr. De Puy. For several inches, immediately below the ball, the galleries were united into a network (n, fig.

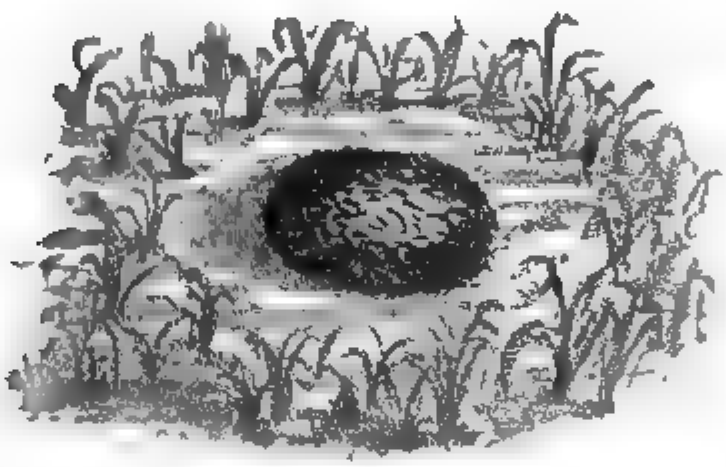


FIG. 3. Flat Circular Mound.—Colorado.

[1] I was unfortunately so situated in the South Park and elsewhere in Colorado, in part by the presence of a sick companion, that I could not delay to open the hills there seen, and make a study of the interior. But I have no doubt that they are arranged like those in Dakota. Will not some observer on that field test the matter by opening a few hills?

5) of communicating ways, by galleries running crosswise. Beyond this, they descended separately, having no connection at all, so far as could be observed. At the time that Dr. De Puy opened this nest the ground was already frozen, making the digging quite difficult. No ants were found except a few stragglers who were encamped within the faggot-ball, the mass of the community having evidently taken up their winter-quarters in regions further underground than the point reached, and not improbably below the reach of frost. The purpose of the faggot-ball can now only be conjectured. I can think of nothing quite analogous to it in any formicary known to me; it suggests the globe of curled rootlets and dry grass which I have found within the cavern of that hymenopterous ally of the ant, the humble-bee (*Bombus virginicus*), and perhaps may serve the same purpose, viz.: that of a general nursery and common living-barracks for the family. At least, I have no better conjecture to venture at this time. It is curious to note such resemblances in habit between distantly removed members of an order of insects; but the fact is no more, indeed not so much of a surprise, as to find in the caves of the Texas Cutting ant (*Atta fervens*) a leaf-paper rudely-celled nest, the product of a habit which exists in perfection in those other hymenopterous allies, the paper-making wasps.

Marriage Flight of the Sexes.—Mr. Russell informed me that the ants appear in the spring with the first vegetation, and by the time of hay-harvest, the latter part of July, numerous swarms of "flying ants" are seen. These, of course, are the young males and females who, being matured, abandon or are pushed out of the home-nest for the marriage flight to meet and pair in the air. At this period the swarms are very annoying to the inhabitants. A person driving or riding over the prairie will find himself suddenly in the midst of one of these hosts. The insects settle upon the body, creep into the openings of the clothes, and produce a disagreeable sensation. Such a swarm settled upon the first house which Mr. Russell built, and the carpenters were compelled to abandon it while in the act of shingling the roof. In the hay-field, the harvesters are often obliged to stop to fight off the winged hosts, and those in charge of the hay-wagon to abandon for the time the stack which is being hauled to the barn, on

account of the annoying creatures. The same is true of the grain harvest which comes later, the appearance of the swarms continuing throughout August and into September. The ants, however, do not sting, my informant averred, notwithstanding their popular title of "the stinging ants." The nervous irritation produced by contact with such numbers is the chief annoyance. Some horses show great excitement under the visits of

FIG 4. Stocking-Shaped Mound.—Colorado.

the swarms, to which the more stolid mule is quite indifferent. These flying ants do not get angry when beaten off, and rush at and follow after the parties attacking them as bees do; they whirl round and round in dense masses, alight upon an object within their path, but show no sign of hostility or wish to pursue human or other animals who approach them. The family of ants to which this genus (*Formica*) belongs, has no members possessed of true aculeate organs. The so-called "sting" is really produced by the insect "biting" or abrading the skin with its mandibles, and then ejecting formic acid from its undeveloped stinging organs into the wound. The smart of the acid is quite severe.

A Useful Insectivorous Habit.—Over against this annoyance

Mr. Russell placed an odd advantage, which he had often observed to be of some importance. When a grain-farm is to be opened, and the prairie sod "broken," a large number of men will be employed to manage the plows. These laborers are provided with barracks or a "camp outfit," and by reason both of personal uncleanliness, and the abundance of certain objectionable insects in the prairie grass, soon become infested with parasites. Flannel clothes and blankets are populous by the middle of June. The manner in which the ants are turned in as scavengers may be illustrated by one instance recited.

"One of my camp cooks," said Mr. Russell, "came one day to borrow a horse. 'What for?' I asked. 'I want to go out on the prairie,' was the answer. 'Number Seven (the name of the camp) is in a pretty lively condition; and, to tell the truth, my clothes are full of lice, and I want to go out to the ant-hills and get rid of them.'

"I gave the man the horse; off he drove, stripped piece by piece, and spread his duds and wraps upon the hills. In a few moments they were fairly covered with ants who thoroughly explored and cleaned every fibre, removing both insects and eggs. The cook came back happy and clean. That was a constant custom then (1880), and is continued by the camp people to this day. The 'cleaning up' takes the greater part of a day."

The Dakotans have thus only discovered a formicarian habit which the Indians of the plains, and old pioneers and campers, utilized many years ago.

Enemies and Destructive Agents.—In the "breaking season," many of the ant-hills are torn up by the plows. At such times flocks of blackbirds, both black and yellow-winged species, follow in the furrows, and feed upon the ants. There seems to be no end to the capacity of these birds for this sort of food. The tender larvæ, exposed by the plowshare, are probably also attractive morsels, but Mr. Russell could not say as to that; to him the birds simply seemed to be picking up ants.

In this connection a fact was related which may well excite surprise. The prairie-fires often completely destroy the hills, burn them quite up, and penetrate far enough beneath the surface to leave a hole that would contain a bushel-basket! This statement, made early in the conversation and while I supposed that I was

listening to some observations upon the Occident ant—for Mr. Russell spoke of the insects by their popular name of "stinging ants"—awakened my suspicion. I knew that a mass of gravel-covered dirt, such as the genuine stinging ants—the Occidents—heap up, would not melt away in such wise before a prairie-fire. A few questions satisfied me that I was on the wrong trail, and that no other ant than *Formica rufa* could build a nest liable to such an accident, and that even she could do so I confess I seriously doubted.

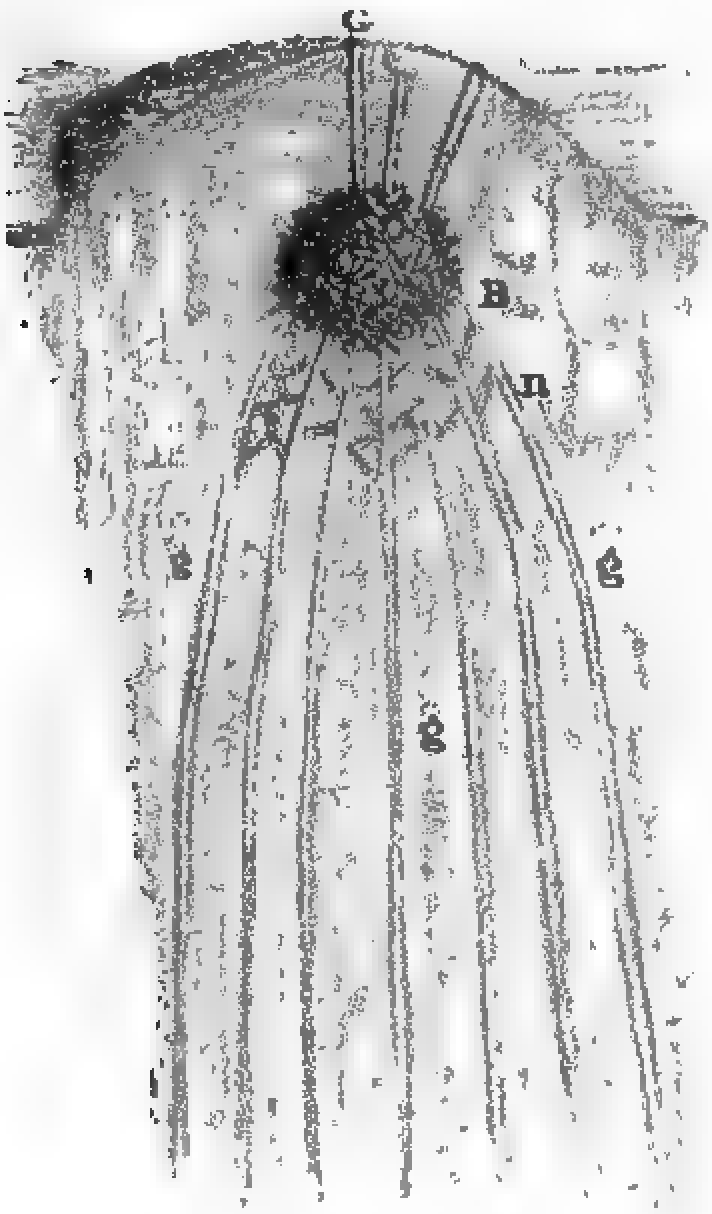


FIG. 6. Half section of mound of *F. rufa*, 4 ft. 4 in. below surface. B, central ball of sticks and straws; g, g, g, galleries; n, network of crossing galleries just below the ball; G, gates.

I had no reason to dispute the veracity of my informant, but I thought it quite as well to test his statements. Accordingly I had Dr. De Puy send me samples of the material of the mounds at points below the surface. The results I have already mentioned, and they show that Mr. Russell's statement is entirely credible. The heavy thatch of dried grass upon the roof, the mixture of soil and decayed straw which composes the cone, the faggot-ball at the heart of the hill, together make up a highly inflammable mass. This freely feeds the flames that eat into the subsoil of the prairie, which is decomposed clay and lime. Thus the story of a casual lay observer, which might have been rejected with apparent reason, was confirmed by careful examination.

The mounds exposed to these prairie-fires are frequently preserved from destruction in a rather remarkable way. A narrow

belt of smooth soil generally surrounds the base of a hill (see figures above), on the outer margin of which (in old formicaries especially) springs up a circle of a tall, stiff, thick-stalked grass, such as always grows upon the heaps which the badger throws up when burrowing after gophers. This grass remains green until late in the fall, and when the dry prairie is swept by the flames, it stands as a breastwork around about the mounds, often deflecting the fire or greatly modifying its destructive effects. In this way the formicaries are kept safe within the girdling ranks of the friendly plant.

Concerning the effects upon the ants of the severe winters of Dakota, I could get no information; but as the frost is said to penetrate to the distance of seven feet, I conjecture that the insects must carry their galleries below that depth, though they are doubtless capable of enduring a very low temperature. The surface is thickly covered with snow during winter months, and it is probable that the ants then are in a semi-torpid state. They reappear in the spring with vegetation. It is a difficult matter to exterminate a colony by artificial means.

The saying is current among the people of this section, reported both by Dr. De Puy and Mr. Russell, that if one wants to dig a well he will find water by going down through an ant-hill. I heard the same proverb in Texas applied to the Agricultural and especially to the Cutting ants. My experience is that these popular traditions often have some basis of truth, but in this case I give little credit to the notion. As these Dakota ant-hills are scattered over the whole rolling prairie country at not very great intervals, there certainly can be no likelihood that the people will ever lack water, as a well might be successfully sunk anywhere, according to emmet indications. A rule of this sort could not be worth much in such a country. In Texas the notion is based upon a supposed necessity for the ants to have access to underground sources of water.

MARCH 18.

The Rev. Dr. McCOOK, Vice-President, in the chair.

Fifty-three persons present.

The following papers were presented for publication:—

"Notes on Species of Fishes improperly ascribed to the Fauna of North America." By David S. Jordan.

"Notes on Tertiary Shells." By Otto Meyer.

The deaths of Dr. A. L. Elwyn, a member, and of Dr. S. B. Buckley, a correspondent, were announced.

Dr. Benjamin Sharp delivered a lecture on the study of biology in Germany introductory to his spring course of lectures on Invertebrate Zoology.

MARCH 25.

The President, Dr. LEIDY, in the chair.

Thirty-nine persons present.

The death of J. T. Audenried, a member, was announced.

On Eumeces chalcides.—Prof. LEIDY remarked that the little lizard presented this evening had been sent to him by a former pupil, Dr. E. A. Sturge, of Petchaburi, Siam. It appears to be a young individual of *Eumeces chalcides* Gunther, the *Lacerta chalcides* of Lin., and *Lygosoma brachypoda* of Dum. et Bib. It is remarkable for its diminutive limbs, provided with five minute toes. Dr. Sturge says the natives regard it as a snake; and, as is common in such cases, consider it to be venomous.

The following were elected members: Albert S. Bolles, Ph. D., R. W. Fitzell, and Jos. W. Griscom.

The following were elected correspondents: Ludwig von Graff, of Aschaffenberg; G. Dewalque, of Liege; Hans Bruno Geinitz, of Dresden; E. Renevier, of Geneva; Henry N. Moseley, of Oxford; and J. T. Burdon Sanderson, of London.

The following were ordered to be printed:—

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS SPHYRÆNA.

BY SETH E. MEEK AND ROBERT G. NEWLAND.

The object of this paper is to give a review of the American species of *Sphyræna*, with detailed descriptions of the four species found on the Atlantic Coasts of America. The specimens examined by us belong, in part, to the Museum of Indiana University; the rest to the U. S. National Museum. All were collected by Professor Jordan at Havana, Cuba; Key West, Fla., and Wood's Holl, Mass.

The two Pacific species have been fully described by Dr. Steindachner (Ichthyol. Beiträge, vii, 1878, 1–4). The remaining species here mentioned, *Sphyræna sphyræna*, we have not seen.

We are under obligations to Professor Jordan, for use of his library and for valuable suggestions.

Analysis of American species of Sphyræna.

a. Scales large, 75 to 85 in lat. line; origin of first dorsal behind root of ventrals, over last third or fourth of pectorals; body compressed; lower jaw with fleshy tip; maxillary reaching past front of orbit; teeth large. *picuda.* 1.

aa. Scales moderate, 110 to 130 in lat. line; body subterete.

b. Pectorals reaching the front of spinous dorsal; maxillary reaching front of orbit; origin of spinous dorsal behind root of ventrals.

c. Lower jaw with fleshy tip; teeth very strong; scales in lat. line 110. *ensis.* 2.

cc. Lower jaw without fleshy tip; teeth strong; lat. line 130. *guaguanche.* 3.

bb. Pectorals not reaching front of first dorsal; maxillary not reaching front of orbit.

d. Eye large; teeth small; interorbital area convex; median ridge of frontal grove not well developed. *picudilla.* 4.

dd. Eye small; teeth larger; interorbital space flattish; median ridge of frontal grove prominent. *borealis.* 5.

aaa. Scales very small, 150 to 170 in lat. line; origin of spinous dorsal well behind tip of pectorals, before the vertical from root of ventrals; lower jaw with fleshy tip.

e. Body very slender, depth 9 or 10 in length; scales in lat. line 150. *sphyræna.* 6.

ee. Body less slender; depth $7\frac{1}{2}$ in length; scales in lat. line 160 to 170. *argentea.* 7.

1. **Sphyræna picuda** (Bloch and Schneider) Poey. *Great Barracuda: Picuda.*

Umbla minor marina (the Barracuda) Catesby, Fishes Carolina, etc., 1731, tab. i.

Picuda Parra, Peces y Crustaceos de Cuba, 1787, 90, tab. 35, f. 2.

Sphyræna sphyræna, var. *picuda*, Bloch and Schneider, Systema Ichth., 1801, 110 (after Parra).

Sphyræna picuda Poey, Memorias Cuba, ii, 1860, 164 (Havana); Günther, Cat. Fish. Brit. Mus., ii, 1860, 336 (San Domingo, Puerto Cabello, Jamaica, West Indies, River Niger); Poey, Proc. Ac. Nat. Sci. Phila., 1863, 179, 187 (identification of Parra's figure); Poey, Syn. Pisc. Cub., 1868, 359 (Havana); Poey, Enum. Pisc. Cub., 1875, 95 (Havana); Goode, Bull. U. S. Nat. Mus., v, 1876, 62 (Bermudas); Goode and Bean, Proc. U. S. Nat. Mus., i, 1878, 381 (name only); Goode, Proc. U. S. Nat. Mus., ii, 1879, 116 (South Florida); Goode and Bean, Proc. U. S. Nat. Mus., ii, 1879, 342 (West Florida, no description); Goode and Bean, Proc. U. S. Nat. Mus., ii, 1879, 146 (Cuba, Bermudas, W. Fla. and S. Fla.); Poey, Anal. Soc. Hist. Nat. Esp., 1881, 210 (Puerto Rico); Goode and Bean, Proc. U. S. Nat. Mus., v, 1882, 239 (Gulf of Mexico, no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., v, 1882, 589 (Charleston, S. C.); Swain, Proc. Ac. Nat. Sci. Phila., 1882, 307 (identification of *Esox barracuda*, Shaw); Jordan and Gilbert, Bull. U. S. Nat. Mus., 16, 1882, 412 (West Indies).

? *Sphyræna becuna* Lacépède, Hist. Nat. Poiss., v, Pl. 9, f. 3, 1803, from a drawing by Plumier made at Martinique); ? Cuv. and Val., Hist. Nat. Poiss., iii, 1829, 340 (after Lacépède); Guichenot, Ramon de la Sagra, Hist. Cuba (Havana); Poey, Memorias Cuba, ii, 1860, 164 (Havana); Poey, op. cit., ii, 1860, 398 (identification with *S. picuda;* species repudianda).

Esox barracuda Shaw, Gen. Zool., v, 1804, 105 (based on Catesby).

Sphyræna barracuda Cuv. and Val., op. cit., iii, 1829, 343 (Brazil); Poey, Memorias Cuba, ii, 1860, 398 (species repudianda); Cope, Trans. Am. Phil. Soc. Phila., 1871, 472 (St. Martins).

Habitat.—West Indies and Brazil; north to Pensacola, Charleston and the Bermudas.

Head 3 in length; depth 2 in head. D. V–1, 9; A. I–9.

Scales 10–75 to 85–10 (the cross series counted from lateral line to front of dorsal and anal fins respectively).

Body oblong, slightly compressed, covered with large scales. Head large, maxillary large, nearly ½ length of head, its posterior margin reaching past front of orbit. Lower jaw, with fleshy tip, bluntly conical. Eye rather small, about 6 in head, equals width of interorbital area. Interorbital area concave, with a shallow median groove (as wide a pupil, at posterior edge of orbit), divided by a ridge in front and behind. Supraocular ridge bony and striate. Preocular ridge present.

Teeth large; premaxillary teeth small, little compressed, irregularly set, nearly uniform in size, somewhat thicker and shorter posteriorly; premaxillary with two pairs of very large compressed teeth, their length more than half width of pupil; anterior ones directed downwards, posterior ones downwards and backwards; teeth in lateral series of lower jaw small anteriorly, increasing gradually backwards, when they nearly equal those on palatines; palatine teeth similar to those on lower jaw, arranged in reversed order.

Distance from tip of snout to front of first dorsal 2$\frac{2}{7}$ in body; second dorsal spine longest, 1⅓ in snout; second dorsal and anal equal; anal inserted under first third of soft dorsal; caudal forked, upper lobe the longest; pectorals reaching beyond front of dorsal, 2½ in head; origin of first dorsal slightly behind the ventrals; cheeks and opercles scaly, about twelve rows of scales on cheeks; upper part of head with small imbedded scales.

Color silvery, darker above; sides in young with about ten dark blotches, which break up and disappear with age. Some inky spots, usually on posterior part of body, are very conspicuous in both old and young specimens. Soft dorsal, anal and ventral fins black, except on margins. Pectorals plain, except upper part of its margin, which is black. Fins of very young specimens nearly plain.

This description is made from an examination of some forty specimens, varying in length from two and three-fourths inches to twenty-eight inches. Nearly all were collected by Professor Jordan, at Key West, Florida; a few at Havana, Cuba.

This appears to be the largest of the Barracudas, reaching a length of at least five or six feet. Its mouth is larger and armed with larger teeth than in any other of our species.

Below is given a table of measurements of six specimens from Key West. The proportions are given in hundredths of the length from tip of snout to end of last vertebra.

Extreme length of fish, in inches,	14.75	10.5	7.5	4.125	4.1	2.6
Length of fish from end of snout to last caudal vertebra, in inches, ...	12.5	8.5	6.2	3.5	3.5	2.3
Greatest depth of body (hundredths of above), ...	16.	16.	16.	16.	14.	10.
Length of head, ...	30.5	33.5	34.	37.	36.	36.
Diameter of eye, ...	5.	6.	6.5	7.	6.5	7.
Length of maxillary, ...	14.5	16.	15.	15.5	15.	14 5
Width of interorbital area, . .	5.5	5.	4.5	4.75	5.	5.
With of base of pèctorals, . .	3.5	3.25	3.	3.	2.25	3.
Length of pectorals, ...	11.5	11.5	11.	11.	11.	10.25
Distance from end of snout, to origin of spinous dorsal, . .	42.5	44.	45.	49.	49.	53.
Distance from end of snout to root of ventrals, ...	38.	41.5	42.	44.	48.	53.
Distance between dorsal fins, .	20.	19.	18.	16.	18.	23.

2. **Sphyræna ensis** Jordan and Gilbert.

Sphyræna forsteri Steindachner, Ichth. Beiträge vii, 1878, 4 [Cape San Lucas to Monterey (not of Cuv. and Val., an East Indian species, as yet not certainly recognized)].

Sphyræna ensis Jordan and Gilbert, Bull. U. S. Fish Comm., 1882, 106 (Mazatlan); Jordan and Gilbert, op. cit., ii, 1882, 109 (Panama. no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., v, 1882, 624 (Panama; no description).

Habitat.—Pacific Coast of America from Cape San Lucas to Panama (East Indies?).

3. **Sphyræna guaguanche** Cuv. and Val. *Guaguanche: Guaguanche Pelon.*

Sphyræna guachancho Cuv. and Val., Hist. Nat. Poiss., iii, 1829, 342 (Havana; on a drawing by Poey; lapsus for *guaguanche*); Guichenot, Ramon de la Sagra, Hist. Cuba, 165 (Havana).

Sphyræna guaguanche Poey, Memorias Cuba, ii, 1860, 166 (Havana); Poey, Enum. Pisc. Cub., 1875, 96 (Havana).

Sphyræna guaguancho Goode and Bean, Proc. U. S. Nat. Mus., ii, 1879, 146 (Wood's Holl, Mass.; Pensacola, Fla.; Cuba); Goode and Bean, Proc. U. S. Nat. Mus., v, 1882, 239 (Gulf of Mexico; no description); Jordan and Gilbert, Synopsis Fish. N. A., 1883, 411; Jordan, Proc. U. S. Nat. Mus., 1884 (Pensacola, Fla.).

? *Sphyræna güntheri* Haly, Ann. Mag. Nat. Hist., ser. iv, vol. xv, p. 270 (Colon; fide Steind.); Steindachner, Ichthyol. Beiträge, vii, 1878, 6 (after Haly).

Habitat.—West Indies, north to Wood's Holl, Mass., and Pensacola, Florida.

Head 3¼ in length; depth 2 in head, D. V–1, 9; A. I–8; scales in lateral line 120 to 130.

Body rather slender, subterete, covered with moderate-sized scales; head large; maxillary small, less than ½ head, scarcely reaching orbit; lower jaw bluntly conical, without fleshy tip; Eye rather large, 5½ in head, a little exceeding interorbital area; interorbital area flat; median groove very shallow, the median longitudinal ridge very small, anterior; supraocular ridge bony, striate; preocular ridge large.

Premaxillary teeth small, 35–40 in number; premaxillary teeth present; anterior palatine teeth larger and more compressed than those on premaxillary, widely set, decreasing in length gradually; teeth in lateral series of lower jaw small and closely-set anteriorly, larger and wide-set posteriorly, about 10 in number; a large compressed tooth at symphysis.

Origin of first dorsal over above tip of pectoral, slightly behind the ventrals; distance between dorsals 5½ in body; distance from tip of snout to spinous dorsal 2¾ in body; scales moderate, almost uniform in size; cheeks and opercles scaly; upper part of head with small imbedded scales.

Color light olive, yellowish on soft dorsal; anal and ventral tips of caudal rays black; top of head dark; dark punctulations on upper part of body; spinous dorsal with some dark punctulations.

The description of this species is taken from three specimens from Havana, Cuba, varying in length from six and one-half to eight inches, and from one specimen collected by Mr. Stearns, from Pensacola, Fla., nineteen inches in length.

Below is given a table of measurements of specimens we have examined. The proportions are given in hundredths of length from tip of snout to the end of last vertebra.

	Pensacola, Fla.	Havana, Cuba.		
Extreme length in inches,	19.	7.5	6.75	6.5
Length of fish from end of snout to last caudal vertebra in inches,	15.75	6.12	5.5	4.9
Greatest depth of body (hundredths of length),	16.5	17.	14.75	14.
Length of head,	30.	35.	32.	33.
Diameter of eye,	5.	6.	6.	6.
Length of maxillary,	15.5	15.	14.5	15.
Width of interorbital area,	4.5	5.	5.	5.
Width of base of pectorals,	2.5	3.	3.	3.
Length of pectorals,	....	13.	13.	12.
Distance from origin of spinous dorsal to end of snout,	42.5	46.	44.5	47.
Distance from end of snout to root of ventrals,	38.5	43.	40.5	42.
Distance between dorsal fins,	20.	19.	17.	18.5

We have not seen the original description of *Sphyræna güntheri* Haly, from Colon (Aspinwall). The abridged description given by Steindachner agrees fully with *S. guaguanche.* We follow Poey in restoring the correct orthography of the name, *Guaguanche.*

4. **Sphyræna picudilla** Poey. *Picudilla.*

Sphyræna barracuda Guichenot, Ramon de la Sagra, Hist. Cuba, 165 (Cuba; fide Poey).

Sphyræna picudilla Poey, Memorias Cuba, ii, 1860, 162, 163, 398 (Havana); Poey, Syn. Pisc. Cuba, 1868, 359 (Havana); Poey, Enum. Pisc. Cub., 1875, 96 (Havana).

Habitat.—Coasts of Cuba.

Head $3\frac{1}{8}$ in body; depth $2\frac{1}{4}$ in head, D. V–1, 9; A. I–9; scales in lateral line 110.

Body rather robust, subterete, covered with scales of moderate size; head rather large; maxillary rather small, about $2\frac{3}{8}$ in head, not reaching orbit.

Jaw with fleshy tip, bluntly conical; eye large, about 5 in head, $1\frac{1}{2}$ times interorbital space; interorbital area flattish; median groove shallow, divided by a very indistinct median ridge; supraocular ridge bony, striate; preocular ridge rather prominent.

Premaxillary teeth small, subconical; dentition as in *Sphyræna borealis*, but slightly weaker; position of spinous dorsal, in comparison to ventrals, variable; distance from tip of snout to origin of spinous dorsal about $2\frac{1}{10}$ in body; pectorals not reaching spinous dorsal; space separating dorsals about $5\frac{1}{2}$ in body; second dorsal equal to and somewhat in advance of anal; cheeks and opercles scaly; small imbedded scales on upper part of head; scales on body moderate, uniform in size. Color light olive, darker above; soft dorsal, anal and ventral fins yellowish; spinous dorsal and pectorals darker; upper parts of preopercle and opercle each with a dark spot; top of head and tip of snout blackish.

S. picudilla is very closely allied to *S. borealis.* Its eye is, however, much larger (when specimens similar in size are compared), and the frontal groove is somewhat different.

The description of this species is taken from four specimens collected by Professor Jordan in Havana, Cuba.

Below is given a table of measurements of the specimens we have examined. The proportions are given in hundredths of the length from the tip of snout to end of last vertebra.

	Havana, Cuba.			
Extreme length of fish in inches,	11.75	11.5	11.25	9.5
Length of fish from end of snout to last caudal vertebra in inches,	9.85	9.66	9.4	7.85
Greatest depth of body (hundredths of length),	14.	14.50	14.25	14.
Length of head,	32.5	31.	32.	32.25
Diameter of eye,	6.25	6.	6.	6.75
Length of maxillary,	12.25	12.	12.	12.
Width of interorbital area,	4.5	4.5	4.5	4.5
Width of base of pectorals,	3.	3.	3.	3.
Length of pectorals,	10.	9.5	9.	9.
Distance from end of snout to origin of spinous dorsal,	47.	47.	47.	46.25
Distance from end of snout to root of ventrals,	47.	47.	48.	46.
Distance between dorsal fins,	17.25	17.50	17.75	17.25

5. **Sphyræna borealis** De Kay. *Northern Barracuda.*

Sphyræna borealis De Kay, N.Y. Fauna, Fishes, 1842, 37, pl. 60, f. 196 (New York); Storer, Synopsis Fish. N. A., 1846 (48); Baird, Ninth Smithsonian Rept., 1854, 12 (Beasley's Point, N. J.); Gill, Rep. U. S. Fish Com., 1872, 808 (no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., i, 1878, 381 (Beaufort, N. C., no description); Goode and Bean, Proc. U. S. Nat. Mus., ii, 1879, 146 (Wood's Holl, Mass.); Bean, Proc. U. S. Nat. Mus., iii, 1880, 102 (Wood's Holl, Mass., no description).

Sphyræna spet Jordan and Gilbert, Proc. U. S. Nat. Mus., i, 1878, 381 (Wood's Holl, Mass.); Jordan and Gilbert, Synopsis Fish. N. A., 1883, 411 (in part; not of Lacépède).

Habitat. — Atlantic Coast of U. S. from Cape Cod to North Carolina.

Head 3 in length; depth $2\frac{3}{5}$; D. V–1, 9; A. I–9; scales in lateral line 115–130.

Body rather slender, subterete, covered with moderate-sized scales; head large, maxillary small, less than $\frac{1}{2}$ head, not reaching front of orbit by $\frac{1}{2}$ diameter of eye; lower jaw with fleshy tip, bluntly conical; eye rather small, about 6 in head, scarcely exceeding width of interorbital area; interorbital area convex; median groove very shallow, divided by a distinct longitudinal ridge, especially well-defined immediately before nostrils; supraocular ridge striate; preocular ridge moderate.

Premaxillary teeth small, about 40 in number; front of premaxillary with two pairs of large teeth (sometimes accom-

panied by smaller ones), canine-like; anterior smallest, directed downwards, posterior ones downwards and backwards; anterior palatines larger than premaxillary teeth, and more compressed and widely-set; posterior ones small and closely-set; order of teeth on lower jaw reversed, but similar to those on the palatines, and smaller, about 10 in series; large tooth near tip of lower jaw present.

Origin of dorsal over or slightly in advance of ventrals, well behind point of pectorals; distance between dorsal fins $5\frac{1}{4}$ in length of body; distance from tip of snout to spinous dorsal $2\frac{1}{10}$ in body; scales moderate, somewhat larger behind soft dorsal and anal; cheeks and opercles scaly; small imbedded scales on upper parts of head.

Color olivaceous, silvery below; young with dusky blotches across the back and along the lateral line.

This description is made from eight specimens collected by Professor Jordan at Wood's Holl, Mass., which vary in length from six and one-fourth to eight and one-half inches. The species does not appear to reach a length of much more than a foot. This species shows several points of similarity to *Sphyræna sphyræna*. It is, however, unlikely that the two are specifically identical.

Below is given a table of four specimens. The proportions are given in hundredths of length from tip of snout to end of last vertebra.

	Wood's Holl.			
Extreme length of fish in inches,	6.5			
Length of fish from end of snout to last caudal vertebra in inches,	5.5	5.5	5.2	5.3
Greatest depth of body (hundredths of length),	13.	12.	13.	12.
Length of head,	34.	33.5	32.	35.
Diameter of eye,	5.	6.	5.5	6.
Length of maxillary,	14.5	13.75	12.5	15.
Width of interorbital area,	4.5	5.	4.	5.
Distance from end of snout to origin of spinous dorsal,	47.5	49.	46.	49.
Distance from end of snout to root of ventrals,	48.	49.	46.	49.

6. **Sphyræna sphyræna** (Linnæus) Bloch. *Spet. Barracuda. Sennet.*

Sphyræna et Sudis auctorum Artedi, Gen. Pisc., 1738, 84 (Coasts of Italy).

Esox dorso dipterygio Linnæus, Mus. Ad. Fried., ii, 1754, 100.

Esox sphyræna Linnæus, Syst. Nat., Ed. 10, i, 1758, 313; Ed. 12, i, 1766, 515 (based on Artedi); Gmelin, Syst. Nat., i, 1788, 1389.

Sphyræna sphyræna Bloch, Ichth., 1797, taf. ccclxxxix; Schneider, Bloch, Syst. Ichth., 1801, 109; Risso, Ichth. Nice, 1810, 332 (Nice).
Esox spet Haüy, Encyclopédie Methodique, iii, Poissons, 1787.
Sphyræna spet Lacépède, Hist. Nat. Poiss., v, 1803, 326–8; Bonaparte, Iconografia della Fauna Italica, iii, Pesci plate with part 152 (Mediterranean); Goode, Bull. U. S. Nat. Mus., v, 1876, 61 (Bermudas).
Sphyræna vulgaris Cuv. and Val., Hist. Nat. Poiss., iii, 1829, 327 (Mediterranean); Günther, Cat. Fishes Brit. Mus., ii, 1861, 334 (Mediterranean and Lanzarote); Günther, Shore Fishes, Challenger, 1880, 3 (St. Jago); no description.
Sphyræna viridensis Cuv. and Val., op. cit., iii, 1829, 339 (St. Jago, Cape Verde Islands).

Habitat.—Coasts of Southern Europe and Northern Africa. Islands of Atlantic (Cape Verde; Madeiras; Bermudas).

7. **Sphyræna argentea** Girard. *California Barracuda.*

Sphyrena argentea Girard, Proc. Ac. Nat. Sci. Phila., vii, 1854, 144 (San Diego); Girard, Pac. R. R. Survey, 1859, 59, pl. xiv, 1 (San Diego); Günther, Cat. Fish. Brit. Mus., 1860, 338 (San Diego); Steindachner, Ichthol. Beiträge, vii, 1 (Cape San Lucas to Monterey); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1880, iii, 29 (San Diego); Jordan and Gilbert, op. cit., 1880, iii, 456 (San Francisco, Monterey, Santa Barbara, San Pedro and San Diego; no description); Jordan and Jouy, op. cit., iv, 1881, 13 (San Pedro and Santa Barbara); Jordan and Gilbert, op. cit., iv, 1881, 44 (Monterey to Santa Barbara); Jordan and Gilbert, op. cit., v, 1882, 358 (identification of *Sphyræna lucasana* Gill; Cape San Lucas).
Sphyræna lucasana Gill, Proc. Ac. Nat. Sci. Phila., 1863, 86 (Cape San Lucas).

Habitat.—Pacific Coast of America from San Francisco to Cape San Lucas.

This species reaches a length of about three feet. We are not able to positively distinguish this species from the published accounts of *S. sphyræna*. We have, however, no doubt that differences will appear on the actual comparison of specimens.

CATALOGUE OF PLANTS COLLECTED IN JULY, 1883, DURING AN EXCURSION ALONG THE PACIFIC COAST IN SOUTHEASTERN ALASKA.

BY THOMAS MEEHAN.

Few new plants have been discovered along the northern Pacific coast, since its examination by the naturalists who accompanied the navigators and explorers of the earlier part of the century; and the results of their labors, as given in Rothrock's *Flora of Alaska*, the *Geological Survey of Canada*, and other lists, seem scarcely to warrant any addition to the botanical literature of this part of the continent. The local histories of these plants are, however, yet not well known; and it seems to me I may add a little to this knowledge by some account of the collection made during July, 1883, in a short trip on the "Idaho," a mail steamer from Portland to Sitka, and trading at various points along the coast at many Indian-fishing settlements.

My object in the journey was simply to get a glance at this interesting country, and the price demanded by the company for my wife, son, and myself, $375, for first-class accommodations for a month, not seeming unreasonable, we took the journey. The only opportunity for collecting was during the few hours spent in taking out and re-shipping stores at the stopping places; and the fact that in this short time and hurried gathering, I was able to collect 275 species, indicates a greater richness of the flora than I expected before starting on the journey. In a number of places, also, the botanizing had to be done under an umbrella in pouring rain, which wholly forbade entrance into the forests, and led to an examination of the shore-lines alone. Rothrock's list embraces but 590 species, including grasses and carices, which, fearing I should not have time in my rapid journey, I seldom touched. My impression is that when we shall have had better opportunities of examining the interior of the territory, the list of Alaskan plants will be still more largely increased. It is true my list embraces the contiguous territory; but probably all north of the Columbia River—of the Straits of Fuca at least—may be regarded as one geographical area up and down which plants may be expected to travel.

Since the publication of Rothrock's Catalogue, other collectors have added to our knowledge of localities, though their work has

not been published. The Herbarium of the Academy of Natural Sciences of Philadelphia is rich through the labors of Harrington, Kellogg and Davidson, and the author is indebted in a great measure to their specimens for assistance in the identification of his own.

The collection made at Bartlett (sometimes called Hood's) Bay, is probably the first made at that point; and it is the interest attached to this that, chiefly, leads the author to publish the paper.

On our return from Chilcat (written Tchillcat in some charts) down the Lynn Channel, we ran up Icy Straits into Glacier Bay, to the fifth or Muir Great Glacier; and on our return, passed in between the Beardslee Islands to the mainland at a point opposite Cross or Icy Sound in about lat. 58.30, called on our chart Bartlett Bay. This is on a peninsula formed by the junction of Icy Sound with the Lynn Channel, and nothing seems to be known of this immense tract of land, except what can be gathered from the not over-friendly Indians who live along the coast in the fishing season. An Indian trader, Mr. Richard Willoughby, told the author that at a point about twenty-five miles above this he had traveled northwest across the peninsula for some forty miles to Pyramid Harbor, near the mouth of the Chilcat, as he was understood to say wholly on ice. It is quite probable that at about a hundred miles north from Bartlett Bay the country is a vast ice-sheet, and there were circumstances which seemed clearly to show that at no great distance of time in the past the whole of the western portion of this peninsula was covered by ice; while on the eastern shore, on Lynn Channel, the forest trees showed the mixture of trees of various ages common to old forests; the forests of the western slope were all comparatively young, and none were evidently over fifty years of age. The earth to fifty feet or more in depth in many places was composed wholly of glacial drift, and on this were the young forest trees. Some remarks on these features more in detail are given at page 187, 1883, of the *Proceedings of the Academy*. Since they were published, Mr. Dall has kindly informed the author that there is historical evidence to show that this part was covered by ice at about the end of the past century. This being so, it becomes a matter of considerable interest to ascertain how so many plants have maintained an existence here—whether they

have appeared since the recession of the ice, or whether they managed to retain their hold during the whole continuance of the ice-sheet.

At our landing place a small stream entered the ocean, and this stream came through a swampy valley a few hundred feet wide, extending into the land for an unknown distance. The hills of drift were on each side of this valley. All the plants were collected within a quarter of a mile of the mouth of this stream, and there is every reason to believe that a larger number of species might have been collected had there been time or opportunity for more inland research along its line. By the margin of the swamp were rocks from five to ten or twenty feet above its ground level, and not covered by drift; but on the more level rocks often with a few feet of sand, which had evidently blown in during the course of years. Yet with every opportunity to do so had there been time for the work, very few of the plants along the line of the stream had extended to the drift deposits close by. These plants were not brought there by the drift. We may say almost with certainty that they were there during the period when the land was covered by ice. How did they manage to maintain themselves under these circumstances? Were they wholly covered by ice? or were there rifts and clefts in the ice-sheet deep enough to allow plants a summer of recuperation?

I think we need not regard the last consideration as one of necessity. There is reason to believe that under a low temperature plants will retain vital power for an indefinite period. Mr. Douglas, of Waukegan, Illinois, once sent to me young trees of *Catalpa speciosa*, that had been placed in sand in a cool cellar and forgotten a year, and that remained the whole twelve months dormant, and grew the next year when planted out. Dr. Maxwell T. Masters, of London, has called attention to the case of an orchid which, as I remember, remained under ground a whole season without growing, and this has been adduced as a probable explanation of the non-appearance in some seasons of plants which are plentiful in others. If a plant will remain dormant one, two or three years under unfavorable conditions for growth, who shall say how much longer a period they may not live, under conditions favorable to dormancy only? I have a strong suspicion that just at or below the freezing-point roots may live for an unlimited number of years; and that a district might be

covered by an ice-sheet for a quarter of a century or more, and the plants beneath retain full vital powers.

By referring again to my remarks on some geological features of this part of Alaska (page 183, *Proc. Ac.*, as cited), it will be seen by a sunken forest of apparently modern trees there is reason to believe that in comparatively recent times this peninsula was clothed with a rich vegetation—that it was of a sudden partially submerged and perhaps as suddenly elevated again a little—and that all these changes have been the work of but a few hundred years. The plants in question have probably survived through all these changes, though perhaps wholly ice-covered at times, and have not been brought here by modern agencies ; and if these suggestions, which are offered only as great probabilities, should get fuller confirmation from any one in the future who may have opportunities of going more fully into an investigation of the spot, it will give additional interest to the study of botany in connection with the great changes which have been going on over the surface of our globe.

From other botanical evidences which southeastern Alaska affords, I am inclined to believe that geological changes in this section have not required the long periods to effect which geologists usually demand. In the vicinity of the Davidson Glacier, a little below Pyramid Harbor, layers of ice may be seen covered by sand and earth, and prevented from rapid thawing—only an occasional spot showing the icy bed beneath—and yet alder and other plants grow within a few hundred yards. On the other hand, near the Muir Glacier, at the point where the river-bed beneath the ice diverges from the glacier's direct course, the only sign of arborescent vegetation is from a few score of willow-bushes, scattered on the mountain-side. Beneath the drift, hundreds of feet below, is a forest buried as it grew. Pines, alders, and similar plants spread so readily in this region, that these bare hill-sides would assuredly be clothed thickly with a forest vegetation, thus replacing the forests which have been swept away, if there had been time enough for the purpose. The immense area and great depth of these treeless drift formations would surely be regarded as requiring perhaps many centuries for deposit, but for the evidence which the botanical observations afford that the whole change must have taken place within very recent times.

In making the catalogue I have followed the example set by Mr. Watson, in the Bibliographical Index; a general view of the relation of the species to each other is furnished by the natural orders in systematic sequence—all the rest is alphabetical. In a systematic work on botany, an alphabetical index appears at the end. A catalogue should be itself an index, as its chief use is for reference and not for systematic study.

RANUNCULACEÆ.

Aconitum napellus Linn. Harrisburg, Alaska.

Actæa spicata, var. **arguta** Watson. Pyramid Harbor, Alaska.

Aquilegia formosa Fisch. Harrisburg, Alaska.

Caltha palustris L. Pyramid Harbor, Harrisburg, Alaska.

Coptis asplenifolia Salisb. Fort Wrangel, Alaska.

Seen also at Sitka and many places through Alaska, but very seldom could I find fruit. The fine specimens from Fort Wrangel were the only good ones found, and I had to look a long time there among the plants before any were seen.

Ranunculus flammula, var. **reptans** Meyer. Departure Bay, B. C., in summer-dried, muddy places.

R. orthorhynchus Hook. Fort Wrangel, Alaska.

Some of the flowers were of a deep orange-brown, but mostly of an ordinary butter-cup yellow. Plant three to four feet high.

R. recurvatus Poir. Fort Wrangel, Alaska.

R. repens L. Harrisburg, Alaska.

CRUCIFERÆ.

Arabis alpina L. Killisnow Island, Alaska.

A. hirsuta Scop. Chilcat Inlet, Harrisburg, Alaska.

A. petræa, var. **ambigua** Regel. Chilcat Inlet, Harrisburg, Killisnow Island.

Common on rocks in Alaska.

Cochlearia Anglica L. Harrisburg, Alaska.

C. officinalis L. Idaho Inlet, a newly explored arm of Cross Sound, by our steamer "Idaho."

A small form growing in mud, covered at high tide. Plants from half inch to one and one-half inches in length, in full flower, but no mature fruit.

Erysimum cheiranthoides L. Killisnow[1] Island, Alaska.

But common through the territory, growing from one foot high to sometimes five feet.

Nasturtium amphibium R. Br. Harrisburg, Alaska.

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[1] Kenasnow on some maps.

VIOLACEÆ.

Viola sarmentosa Dougl. Harrisburg, Alaska. Perfect flowering.

V. sarmentosa. In open gravelly places. Departure Bay, Alaska. Cleistogamous.

Arenaria lateriflora L. Pyramid Harbor, Alaska.

Cerastium alpinum L. Bartlett Bay, Alaska.

Honkenya peploides Ehrb. Killisnow Island, Alaska.

I did not see Indians eating this, but I saw it in their canoes, brought from places where it grew; and often saw pieces lying around where their camp-fires had been. I believe they cook and eat it.

Spergula arvensis L. Harrisburg, Alaska; clefts of rocks by the seaside.

Stellaria borealis Bigel. Harrisburg, Sitka, Alaska.

S. crispa Ch. and Sch. Pyramid Harbor, Harrisburg, Alaska. Common.

S. longifolia Muhl. Harrisburg, Alaska.

Sagina procumbens L. Sitka, Alaska.

PORTULACACEÆ.

Claytonia sarmentosa C. A. Mey. Fort Wrangel, Alaska.

This is evidently the plant intended by Pursh as *C. lanceolata*, but I believe my plant is what is regarded as above. It is common along the coast, and is extremely variable. Eaten by Indians.

Montia fontana L. Sitka, Alaska.

I saw only some half dozen small plants under a cabin set on logs, and suspected it was an introduced plant.

HYPERICACEÆ.

Hypericum Scouleri Hook. Departure Bay, B. C.

MALVACEÆ.

Sidalcea malvæflora Gray. Victoria, B. C.

This appears to me somewhat different from the plant of the more southern portion of the continent; but Mr. Serano Watson decides it to be this species. Two to three feet high.

GERANIACEÆ.

Geranium erianthum D. C. Killisnow Island, Alaska.

G. pusillum Lin. Port Townsend, W. T.; Victoria, B. C.

Impatiens fulva Nutt. Harrisburg, Alaska.

SAPINDACEÆ.

Acer rubrum L. Pyramid Harbor, Alaska.

LEGUMINOSÆ.

Astragalus alpinus L. Pyramid Harbor, Alaska.

A. hypoglottis L. Bartlett Bay, Alaska.

Lathyrus maritimus Bigl. Pyramid Harbor, A'aska.

Lupinus Nookatensis Don. Bartlett Bay, Alaska.

L. micranthus Doug. Victoria, B. C.

Oxytropis Lamberti Pursh. Pyramid Harbor, Alaska.

Psoralea physodes Dougl. Port Townsend, W. T.

More capitate than I have before seen it.

Trifolium involucratum Willd. Port Townsend, W. T.; Victoria, B. C.

T microdon Hook. Port Townsend, W. T.; Victoria, B. C.

Vicia gigantea Hook. Sitka; Killisnow Island, and other places in Alaska.

ROSACEÆ.

Amelanchia alnifolia Nutt. Astoria, Or.

A dwarf variety, with large black, and excellent fruit.

Dryas octopetela L. Bartlett Bay, Alaska.

Plants without inflorescence. Glacier Bay, near Muir Glacier, a single large plant with fruit, on a moraine deposit.

Fragaria chilensis Duch. Chilcat Inlet, Alaska, also in Bartlett Bay.

This species interested me by the dark color of the upper surface of the leaves as contrasted with the lower; the deeply incised first (autumn) leaves; the enormous runners, often two feet long before bearing a plant; the very long—often over a foot—and slender common peduncles of the later flowers, and very short, often nearly sessile common peduncles of the earliest flowers; the very large flowers; and pale, scarcely red fruit. The Indian boys and girls go out and collect them, as our boys and girls do. At Killisnow Island, I did not see them growing, but Indian women brought them to our landing, and knew enough of our language to ask "ten cents" for small measures of them.

F. vesca L. Departure Bay, B. C.

I believe I saw it in Alaska, but have no specimen.

Geum macrophyllum Willd. Pyramid Harbor. Common in Alaska.

Neillia opulifolia B. & H. Departure Bay, B. C.

Nuttallia cerasiformis T. & G. Astoria, Or.

Pyrus rivularis Doug. Astoria, Or.; Victoria, B. C.; Sitka, Alaska.

P. sambucifolia Ch. & S. Pyramid Harbor, Alaska.

I saw but one plant, on an Indian trail so steep and slimy, it impossible to climb. It had no fruit; but on the trail were

several red fruit, evidently of this species, but not one-fourth the ordinary size, about the size of an elderberry. At Sitka I saw the plant with the full-sized fruit, half mature, that we see further south.

Potentilla fragiformis Willd., var. **villosa**. Chilcat Inlet, Sitka, Alaska.

Varying in habit.

Prunus emarginata Walp., var. **mollis**. Astoria, Or.

Rosa gymnocarpa Nutt. Departure Bay, B. C.

In open places a shrub two to three feet, but along the trail through woods not too dense, it would rise six to eight feet high; and the red fruit, one to three on a common peduncle, made a very ornamental shrub.

R. Nutkana Presl. (**R. cinnamomea** Hook). Pyramid Harbor, Alaska; Victoria, and some forms everywhere.

Varies very much in size and form of fruit, sometimes having them as large as Damson plums; seems generally characterized by very large stipules, especially on the upper part of the flowering stem.

Rubus leucodermis Dougl. Departure Bay, B. C.; Astoria, Or.

Leaves commonly pinnate, with five leaflets. Fruit better than the Eastern Black Cap, which it resembles.

R. nutkanus Moçino. Killisnow Island: but very common throughout the coast.

R. spectabilis Pursh. Killisnow Island; but everywhere throughout Alaska.

The fruit is most prevalently of an amber-yellow, but often scarlet or red. The flavor is wholly that of a blackberry, rather than of a raspberry, and they vary very much in size. The Indian women of Sitka have very large ones, which they sell on the road-side. At Killisnow Island I saw two Indian women, whom I encountered in the woods, gathering the soft green tops of the summer shoots in large bunches. They made signs to me that they ate them; I suppose cooked.

R. stellatus Smith. Sitka.

Though the plants seemed abundant, many flowers were abortive, and a large number had but a single red carpel, or two or three only. I had trouble to find a few with perfect berries.

R. ursinus Ch. & S. Departure Bay, B. C.

Spiræa Aruncus L. Harrisburg, Alaska; Departure Bay, B. C.

S. discolor Pursh. Victoria, B. C.; Harrisburg, and common along the Alaskan coast.

I am not able to decide to which of the varieties these northern

forms should be referred, but they strike one differently from the plant I have collected in the Rocky Mountains, *S. dumosa.*

Sanguisorba canadensis C. & S. Bartlett Bay, Alaska.

SAXIFRAGACEÆ.

Heuchera glabra Willd. Harrisburg, Alaska.

H. micrantha Dougl. Harrisburg, Alaska.

Parnassia palustris L. Bartlett Bay, Alaska.

Ribes bracteosum Dougl. Pyramid Harbor, Alaska, and common along the coast.

Very striking by the stems as thick as one's finger, and very stout annual shoots, enormous maple-like leaves, long leaf-stalks, and racemes eight to ten inches long. The berries are called by the Indians "Shaum," as I understood them. They are gathered and preserved in fat for winter use.

R. divaricatum Dougl. Port Townsend, W. T.

R. lacustre Pois. Port Townsend, W. T.; Harrisburg, Alaska.

R. Hudsonianum Richard. Fort Wrangel, Alaska.

This seems to grow only about stumps or dead logs. I believe the berries are used by Indians, as are those of *R. bracteosum.*

R. sanguineum Pur. Departure Bay, B. C.

R. subvestita Hook.?

Fruit very large—as large as the English gooseberry, which even the foliage somewhat resembles. The berry is covered by viscid hairs, by which even a large berry will adhere to the finger. The color of the fruit is scarlet, but the flavor is insipid. The shrub grows about four to five feet high.

Saxifraga leucanthemifolia Mx. Harrisburg, Alaska.

S. tricuspidata Retz. Chilcat Inlet, Alaska.

Tellima grandiflora R. Br. Harrisburg, Alaska.

Tiarella trifoliata L. Port Townsend, W. T., and northwards.

CRASSULACEÆ.

Sedum spathulæfolium Hook. Victoria, B. C.

S. Rhodiola D. C. Bartlett Bay, Alaska.

DROSERACEÆ.

Drosera rotundifolia L. Fort Wrangel, Alaska.

ONAGRACEÆ.

Circæa alpina L. Harrisburg, Alaska.

Epilobium affine Bong. Fort Wrangel, Sitka, Alaska.

E alpinum L. Pyramid Harbor, Killisnow Island, Alaska.

E. latifolium L. Pyramid Harbor, Muir Glacier, Alaska.

E. minutum Lindl. Fort Wrangel, Alaska.

E. paniculatum Nutt. Departure Bay, B. C.

E. spicatum, Lam. Port Townsend, W. T.

About eighteen inches or two feet, with narrow leaves (¼ inch), tapering gradually at both ends. Victoria, B. C., two to three feet, leaves broader; Killisnow Island, Alaska, four to five feet high, leaves one to one and one-half inches broad, spike leafy, and inclined to be paniculate.

CUCURBITACEÆ.

Echinocystis lobata T. & G. Columbia River, above Astoria, Or.

UMBELLIFERÆ

Archangelica Gmelini D. C. Harrisburg, Kaigan, and other places in Alaska.

The few whites we met called it "celery." In many Indian lodges I saw bundles of fresh flower stems, and in some cases Indians peeling or stringing them as we do rhubarb stalks, and eating them raw with apparent relish.

It is interesting to note that Linnæus, in his tour in Lapland, notes that the Laplanders use this plant in the same way.

Crantzia lineata Nutt. Columbia River, above Astoria, Or.

Heracleum lanatum Mx. Harrisburg and many other places in Alaska.

Geological survey of Canada says Indians eat the leaf-stalks; but I saw no evidence of this in Alaska.

Ligusticum scoticum L. Idaho Inlet, Killisnow, Harrisburg, Alaska.

Common along the Alaskan coast.

Œnanthe sarmentosa Presl. Departure Bay, B. C.

Sanicula Menziesii Hook & Arn. Port Townsend, W. T., Victoria, B. C.

Sium cicutæfolium Gmel. Astoria, Or.

ARALIACEÆ.

Fatsia horrida B. & H. Pyramid Harbor, Harrisburg, and other places in Alaska.

Often forming dense underbrush in forests, growing four to eight feet high, and making traveling impossible unless with great labor. An Indian explained to me that it was in common use with them as a medicine.

CORNACEÆ.

Cornus stolonifera Mx. Pyramid Harbor, Alaska.

C. canadensis L. Sitka, Fort Wrangel, Alaska.

CAPRIFOLIACEÆ.

Lonicera hispidula Dougl.

I see no difference between the yellow and red forms, though they strike one as distinct when growing. The red form, Port Townsend, W. T.

L. involucrata Banks. Kaigan, Alaska.

Seemingly different from the Colorado plant, but chiefly in size and habit. The plant has a sarmentose or half-climbing character. It grows up the hemlock trees as they grow; and, when the lower branches of the hemlock die, the stems of the Lonicera remind one of grapevines. But the plant travels along the lower living or dead branches of the hemlock, outwards to the light. Away from trees they are self-supporting, but yet the branches are somewhat pendulous. In such cases eight to ten feet high.

Linnæa borealis Gron. Port Townsend, W. T.

Sambucus racemosa Mx. Fort Wrangel, Alaska.

Familiar as I am with the var. *pubens* of the Allegheny and Rocky Mountains, I could hardly believe the forms deserved to be regarded as identical after seeing the Alaska plants, especially those about Fort Wrangel. The inflorescence was strictly racemose, which the more eastern form is not. Shrubs six to ten feet, and as wide, covered with brilliant scarlet berries, were extremely attractive.

Symphoricarpus racemosus Mx. Victoria, B. C.

Viburnum ellipticum Hook. Pyramid Harbor, Alaska.

RUBIACEÆ.

Galium asprellum Mx. Victoria, B. C.

Slender habit. Harrisburg and Sitka, coarse and straggling.

G. triflorum Mx. Port Townsend, W. T.; Victoria, B. C.; Harrisburg, Sitka, Alaska.

Leaves getting broader from each location northwards.

COMPOSITÆ.

Adenocaulon bicolor Hook. Port Townsend, W. T.

Achillea millefolium L. Port Townsend, W. T.; Victoria, B. C.; Harrisburg, Alaska.

Much more vigorous and hairy than the eastern plant, and generally with deep rosy, occasionally with pinky white, but rarely, if ever, with pure white flowers.

Anaphalis margaritacea Benth. Bartlett Bay, Chilcat Inlet, Alaska.

Antennaria alpina Gaert. Chilcat Inlet, Bartlett Bay, Alaska.

Arnica Chamissonis Less. Bartlett Bay, Alaska.

Aster Douglasii Hook. Columbia River, Astoria, Or.

Bahia lanata Nutt. Port Townsend, W. T.; Victoria, B. C.

Cnicus edulis Gray. Columbia River, above Astoria, Or.; Departure Bay, B. C.

Erigeron acre L. Bartlett Bay, Alaska.

E. alpinum L. Bartlett Bay, Alaska.

E. Philadelphicum. Victoria, B. C.

E. speciosum D. C. Port Townsend, W. T.

Gnaphalium purpureum Lin. Port Townsend, W. T.

Hieracium albiflorum Hook. Port Townsend, W. T.

H. cynoglossoides Amt. Touv. Port Townsend, W. T.

H. Scouleri Hook. Departure Bay, B. C.

Leontodon hirsutum Hook. Port Townsend, W. T.

Densely hairy; Victoria, B. C., slightly hairy and more slender than the Port Townsend plant.

Madia filipes Gray. Port Townsend, W. T.; Victoria, B. C.

M. Nuttalliana Gray. Port Townsend, W. T.; Victoria, B. C.

Micromeris Bigelowii Gray. Victoria, B. C.

Nabalus alatus Hook. Harrisburg, Fort Wrangel, Sitka, Alaska.

Pyrethrum Parthenium L.

A single plant on the Columbia River, four miles above Astoria, most likely introduced, but worth recording as noting the commencement of naturalization.

Senecio pseud-arnica Hook. Killisnow Island, Alaska.

Solidago elongata Nutt. Victoria, B. C.

S. multiradiata Ait. Bartlett Bay, Alaska.

Sonchus oleraceus L. Astoria, Or.; Departure Bay, B. C.

Quite common, but I suppose introduced in some way.

Taraxacum palustre Lin. Departure Bay, B. C.; Port Townsend, W. T.

Campanula rotundifolia L. Chilcat Inlet, Alaska.

In the crevices of rocks; the flowers very large, and the stems very stout. Indian name "narl," and represented as "good for medicine."

C. Scouleri Hook. Departure Bay, B. C.

About four inches high, densely leafy, and leaves narrow in open rocky places; a foot high, slender, leaves broad and scattered in somewhat shady places.

ERICACEÆ.

Arbutus Menziesii Pursh. Departure Bay, B. C.

Bryanthus glanduliferus Gray. Bartlett Bay, Alaska.

Cassiope Mertensiana Don. Bartlett Bay, Alaska.

C. tetragona Don. Bartlett Bay, Alaska.

Gaultheria Shallon Pursh. Port Townsend, W. T.

One to two feet high; Kaigan and other places in Alaska, two to four feet or more, and forming a dense undergrowth rendering the forest almost impassable.

Kalmia glauca L. Fort Wrangel, Alaska.

Ledum palustre L. Fort Wrangel, Sitka, Alaska.

Leaves broader as the plant extends northwards.

Menziesia ferruginia Smith. Fort Wrangel, Sitka, and Pyramid Harbor, Alaska.

Moneses uniflora Gray. Bartlett Bay, Alaska.

Pyrola chlorantha Swartz. Pyramid Harbor, Alaska.

P. rotundifolia Lin. Port Townsend, W. T.

P. secunda Lin. Pyramid Harbor, Alaska.

Vaccinium ovalifolium Sm. Fort Wrangel, Alaska.

V. ovatum Pursh. Columbia River, above Astoria, Or.

V. parvifolium Sm. Columbia River, above Astoria, Or.

V. uliginosum L. Bartlett Bay, Alaska.

V. Vitis-Idæa L. Sitka, Fort Wrangel, Alaska.

PLUMBAGINACEÆ.

Armeria vulgaris Willd. Victoria, B. C.

PRIMULACEÆ.

Dodecatheon Meadia L. Killisnow Island, Alaska.

Var. *macrocarpum* probably. Clefts of rocks along the shore.

Glaux maritima L. Fort Wrangel, Alaska.

Primula borealis Duby. Bartlett Bay, Alaska.

Trientalis Europæa Linn. Sitka, Alaska.

T. Europæa, var. *arctica* Fisch. Harrisburg, Alaska.

OLEACEÆ.

Fraxinus Oregana Nutt. Victoria, B. C.

But perhaps introduced.

GENTIANACEÆ.

Gentiana amarella L., var. *acuta* Engel. Departure Bay.

POLEMONIACEÆ.

Collomia heterophylla Hook. Columbia River, above Astoria.

There is in the Herbarium of the Academy of Natural Sciences of Philadelphia, a specimen of this, and perhaps from the same locality, simply marked "Gilia, Columbia River." In the same paper is a specimen marked *Navarretia heterophylla* Benth., "from Durand's Herbarium," which is almost smooth, not viscous as this is, and accords with the figure in Hook. Bot. Mag., t. 2895, which this and Nuttall's specimen scarcely do.

BORRAGINACEÆ.

Mertensia maritima Don. Killisnow Island, Alaska.

SCROPHULARIACEÆ.

Boschniakia glabra C. H. Meyer. Pyramid Harbor, Alaska.

Among alders, apparently in the track of a receding glacier. A long woody thread descends from the base of the scaly flower stem, but in the haste of collecting I did not find to what the thread was attached, if it were attached at all. The Indians make no use of the plant, but class it with plants which are "cultash" (no good). Their name for this is "Asquakali."

Castillija hispida Benth. Pyramid Harbor, Alaska.

C. miniata Dougl. Victoria, B. C.

C pallida Kunth. Pyramid Harbor, Alaska.

Common through Alaska, and varying very much, especially in the colors of the bracts and flowers.

Euphrasia officinalis L. Bartlett Bay, A'aska.

Mimulus dentatus Nutt. Astoria, Or.

Though from the numerous variations of *M. luteus* L. this might be regarded as but a variety of that species, it has a very distinct appearance when seen growing. The dark, blue-green, thick leaves are particularly striking. This might be owing to the sub-saline locality—so many maritime plants having foliage of this character; but the normal *M. luteus* may be often seen in similar situations, and without these characters. Dr. Gray, in *Botanical Gazette*, now regards it as a good species.

Mimulus luteus L. Harrisburg, Alaska.

Common along the coast.

Pedicularis palustris, var. *Wlassoviana* Bunge. Bartlett Bay, Alaska.

Scrophularia Californica Cham. Astoria, Or.

Veronica scutellata L. Departure Bay, B. C.

V. alpina L. ? Bartlett Bay, Alaska.

LENTIBULARIACEÆ.

Pinguicula vulgaris L. Bartlett Bay, Alaska.

LABIATÆ.

Brunella vulgaris L. Victoria, B. C.

This does not strike me quite like the introduced form of the Eastern States, and is most likely indigenous.

Galeopsis Tetrahit L. Sitka, Alaska.

A patch of a few yards in extent, but seemingly many years established, on the shore, near the old city, was the only locality noted on the journey, and suggests that the plant may have been a Russian introduction.

Mentha canadensis L. Departure Bay, B. C.

Micromeria Douglasii Benth. Port Townsend, W. T.

Stachys ciliata Doug. Victoria, B. C.

Damp, grassy places. A very ornamental plant.

PLANTAGINACEÆ.

Plantago major, var. *Asiatica* D. C. Fort Wrangel, Alaska.

P. major, var. *minima* Dec. Departure Bay, B. C.

Both these forms grow in saline soil, and the location can have no influence on their very distinct appearances.

POLYGONACEÆ.

Polygonum viviparum L. Killisnow Island, Alaska.

Rumex domesticus Hart. Hoona (Bartlett Bay).

Petioles a foot long, and half an inch wide. Leaf-blade about a foot long and nine inches wide at the base, tapering towards the obtuse apex. My specimens moulded in drying too badly to determine properly. I have followed other collectors in naming the plant, though I am inclined to regard it rather as *R. Patienta* L. The petioles are eaten by the Indians as we use the garden rhubarb.

R. salicifolius Wienm. Bartlett Bay, Alaska.

CHENOPODIACEÆ.

Atripex patula, var. *littoralis* Gray. Harrisburg, Sitka, Fort Wrangel, and other places along the coast.

EMPETRACEÆ.

-trum nigrum L. Bartlett Bay, Alaska.

BETULACEÆ.

Alnus rubra Bong. Pyramid Harbor, Kaigan, Alaska.
A. viridis D. C. Harrisburg, Alaska.

I have identified these with much hesitation, regretting on my return home to find my material confined to a single branch of each—the alders of Alaska being worthy, as I now believe, of closer investigation. My botanizing at Harrisburg, and at Kaigan, had to be done beneath an umbrella and in pouring rain—unfavorable for the close study of arborescent growth. If the identifications are correct, the names would deserve to be transposed. The "Harrisburg" species is the one prevalent from there south through British Columbia to the Columbia River, often making a tree I should judge from thirty to forty feet high, and with a trunk occasionally say five to six feet in circumference. The bark of the trunk is a dark reddish brown. The finely serrulate leaves, however, seem precisely like the leaves of *A. viridis*, as I have collected it on the mountains of New Hampshire, and North Carolina, though it is difficult to believe so small a shrub there, should be so fine a tree here.

The alder of Kaigan and Pyramid Harbor is a much larger tree, with a gray and rather smooth bark, even when quite aged. At Pyramid Harbor, a summer settlement for salmon-fishing, Indians had cut some down, and were making canoes—dug-outs—of them. From memory I am sure some of these logs must have been near three feet thick, and thirty feet long—the original height of the tree being probably more than double this. These were on rich bottom lands, near but not on the retreating glacier's track. On the track the same plant apparently made a dense shrubby growth, not taking on at all a tree-like character.

Betula papyracea Ait. Chilcat Inlet, Alaska.

Probably this species; but the leaves seem all cordate and densely woolly. Only a single tree was seen, not mature apparently; but there might have been more, for when found it was approaching midnight and getting almost too dark for further explorations.

SALICACEÆ.

Salix Pallasii And. Bartlett Bay, Alaska.
S. reticulata L. Bartlett Bay, Alaska.
S. Sitchensis Sanson, var. *denudata* And. Bartlett Bay, Alaska.
S. Barclayi And. Bartlett Bay, Alaska.

CUPULIFERÆ.

Quercus Kellogii Newb. Victoria, B. C.

Where exposed to the sea-breezes this seemed but a small "chinquapin"-like bush two or three feet; but only a short distance in the island it becomes a fine timber tree. I believe this is as far north as I saw any species of oak growing.

TAXACEÆ.

Taxus brevifolia Nutt. Victoria, B. C., and Port Townsend, W. T.

A few trees in the vicinity of Victoria, quite as large as some seen in the Calaveras grove of Sequoias, and probably growing further north, though not seen.

CONIFERÆ.

Abies grandis Lindl. Port Townsend, W. T.; Victoria, B. C.

Chamæcyparis Nutkænsis Spach.

Is said by authors to be very abundant from the Columbia River northward through British Columbia and southeastern Alaska. I could not find a single specimen, though continually on the lookout for it, and the owner of a saw-mill at Killisnow Island informed us that the "yellow cedar" was an extremely rare tree in that region.

Picea Sitchensis Carriere (*Abies Menziesii*, of some modern authors).

Common everywhere through British Columbia to the head of Glacier Bay, Alaska, at the latter place forming buried forests near the Muir Glacier and Bartlett Bay. At Kaigan some trees measured twenty-one feet round. It evidently loves atmospheric moisture, and grows on barren rocks, when it is under these atmospheric conditions, quite vigorously; and in this way assists in forming a covering of earth over the rocks. At Kaigan there were trees of many years old, growing from the top of the Indian "totem poles," half as tall as the poles at times.

Pinus contorta Dougl. Chilcat Inlet.

A tree about twenty or thirty feet high, with a rather flattish, spreading head; short ovoid cones, and which are not at all oblique, growing among rocks along the coast.

Also at Bartlett Bay, where it is a stout, very vigorous shrub, branching from the base, without any attempt to make a leader, and much resembling the habit of *Pinus montana* of Europe. The plants were very fertile, the cones being freely scattered among the branches, and cylindrical, without any tendency to obliquity.

Following the Botany of California this would probably be referred to the true *P. contorta*, of Douglas, and the first named to *P. contorta*, var. *Murrayana*, though the characters, as I find them, do not quite agree. I have thought best to leave the determination indefinite.

Tsuga Mertensiana Carriere. Port Townsend, W. T.; Victoria, B. C., and common along the coast. Specimens from Fort Wrangel.

This is the "hemlock" of these parts, and some of the trees at Sitka and Fort Wrangel were as large, at least, as the best specimens of the hemlock found at the East.

Pseudtsuga Douglasii Carriere. Port Townsend, W. T.; Victoria, B. C.: Sitka, Alaska.

Thuja gigantea Nutt. Port Townsend, W. T.; Victoria, B. C.; Kaigan, Alaska. Common along the coast.

This, *Tsuga Mertensiana*, and alders, form most of the arborescent vegetation of the southeastern Alaskan coast.

ORCHIDACEÆ.

Habenaria dilitata Gray. Port Townsend, W. T.

As it seems to me, though it may be a form of *H. leucostachys* Wat.

H. hyperborea Bartlett Bay, in glacial drift.

Spiranthes Romanzoffiana Cham. Bartlett Bay, Alaska.

IRIDACEÆ.

Sisyrinchium anceps L. Sitka

Not abundant, but probably indigenous.

LILIACEÆ.

Allium acuminatum Hook. Victoria, B. C.

Brodiæa lactea Watson. Port Townsend, W. T.; Victoria, B. C.

B. grandiflora Watson. Victoria, B. C.

An imperfect specimen; probably belongs here.

Prosartes Oregana Watson. Victoria, B. C.

Smilacina bifolia, var. **dilitata** Wood. Sitka, Fort Wrangel, and many places along the coast, but seldom found in fruit.

The fruiting specimens here from Sitka, have also three, and sometimes four, leaves on the scape.

Streptopus amplexifolius D. C. Fort Wrangel, Alaska.

Tofieldia glutinosa Willd. Bartlett Bay, Alaska.

ARACEÆ.

Lysichiton Camtschatcense Schott. Fort Wrangel, and throughout the coast.

Leaves larger, narrower and much more glaucous than its analogue, the skunk cabbage of the Eastern States.

Two young deer, about a year old, were captured while attempting to swim across a four-mile stretch of an arm of the sea, and brought on board the steamer, the captain intending to take them to San Francisco. They took well to their imprisonment; but after some time, the ship's boat brought back a lot of these leaves. I remarked to the captain that the acrid leaves would probably be fatal to the animals, but he remarked that they would not eat them so freely if injurious, and they were fed continuously for several days on them, when one died. The captain's idea was that it died of sea-sickness. It had been very rough the night it died. The other one finally recovered.

NAIDACEÆ.

Triglochin maritimum L. Fort Wrangel, Alaska.

T. palustre L. Bartlett Bay, Alaska.

JUNCACEÆ.

Juncus arcticus Willd. Bartlett Bay, Alaska.

J. Balticus Dethard. Fort Wrangel.

Varies in size in different localities.

J. bufonius L. Sitka, Alaska.

J. filiformis L. Astoria, Or.

J. xiphioides Meyer. Fort Wrangel, Alaska.

Luzula campestris D. C. Sitka, Alaska.

L. spadicea, var *parviflora* Meyer. Fort Wrangel, Alaska.

CYPERACEÆ.

Carex cryptocarpa. Alaska.

C. muricata Linn. Alaska.

C. undetermined. Alaska.

C. undetermined. Alaska.

Eriophorum gracile Koch. Fort Wrangel, Alaska.

Scirpus pungens Vahl. Fort Wrangel, Alaska.

GRAMINEÆ.

(Identified by F. Lamson Scribner.)

Agrostis alba var. *scaberrima*. Bartlett Bay, Alaska.

A. canina, var. Sitka, Alaska.

A. exarata Trin. Sitka, Alaska.

A vulgaris Nutt. Sitka, Alaska.

Aira caryophyllea L. Victoria, B. C.

Alopecurus aristulatus Mx. Departure Bay, B. C.

Atropus angustata Ledeb. Sitka, Alaska.

Deschampsia elongata. Departure Bay, B. C.

Deyeuxia Langsdorffii Kunth. Fort Wrangel, Alaska.

Elymus Sibiricus L. Departure Bay, B. C.

This seemed so great a favorite with the birds that it was with difficulty I got a few complete spikes for herbarium.

Elymus mollis Trin. Pyramid Harbor, Alaska.

This is a broad-leaved, strong-growing kind, growing along sandy shores as *E. arenarius* does in other places; and not uncommon along the coast.

Festuca ovina, var. *duriuscula.* Bartlett Bay, Alaska.

Festuca ovina, var. *duriuscula.* Sitka, Alaska.

The last spike much more decompound.

Glyceria angustata Griesb. Idaho Inlet, Cross Sound, Alaska.

Mr. Scribner refers it to Griesbach's species without deciding whether or not it should be united with *G. distans* G. The plant was growing in mud overflowed at high-tide, and formed a dense carpet of green grass on the mud. The growth is about four to six inches.

G. distans Gr. Fort Wrangel, Alaska.

G. pauciflora Presl. Sitka, Alaska.

Hierochlœ borealis L. Bartlett Bay, Alaska.

Holcus lanatus L. Astoria, Or.

Only one plant noted, on the hills along the river, about four miles above Astoria. *Pyrethrum Parthenium* was also collected within a few feet of it.

Hordeum nodosum L. Bartlett Bay, Fort Wrangel, Alaska.

Phleum alpinum L. Bartlett Bay, Alaska.

P. pratense L Sitka, Alaska.

Common in grassy places; but possibly introduced.

Poa pratensis L. Bartlett Bay, Alaska.

Both the green and the bronzy forms.

Trisetum spicatum, var. *molle,* Gray. Bartlett Bay, Alaska.

EQUISETACEÆ.

Equisetum variegatum Sch. Bartlett Bay, Alaska.

FILICES.

Adiantum pedatum L. Harrisburg, Killisnow Island, Alaska.

Pinnules more deeply lobed, and the divisions of the stipe more elongated and slender than the Eastern form.

Aspidium munitum Kaul. Departure Bay, B. C.

Very variable in size; but always seeming very fertile.

A. aculeatum Swartz. Harrisburg, Alaska.

Cryptogramme acrostichoides R. Br. Bartlett Bay, Alaska.

Very vigorous, fronds 9 to 10 inches.

Cystopteris bulbifera. Pyramid Harbor, Alaska.

Cystopteris fragilis. Pyramid Harbor, Alaska.

Lomaria Spicant Desveaux. Sitka, Alaska.

Phegopteris Dryopteris, Fee. Fort Wrangel, Alaska.

Phegopteris polypoides Fee. Bartlett Bay, Alaska.

Polypodium falcatum Kellogg. Killisnow Island, Alaska.

Polypodium vulgare L. Killisnow Island.

Pteris aquilina L. Victoria, B. C. Fort Wrangel, Alaska.

LYCOPODIACEÆ.

Lycopodium annotinum L. Killisnow Island, Alaska.

NOTES ON SPECIES OF FISHES IMPROPERLY ASCRIBED TO THE FAUNA OF NORTH AMERICA.

BY DAVID S. JORDAN.

The study of the geographical description of species is impossible without a correct knowledge of the species themselves and of the localities whence specimens have been obtained. Every attempt at generalization in this field has been more or less vitiated by errors of identification or errors as to locality. No accident, unfortunately, is more common in museums, or in private collections, than the mixing of specimens from different localities, and the false records arising from such confusion have a wonderful vitality. The early writers in systematic zoölogy had no conception of the problems of geographical distribution, and many modern writers have a very low estimate of the importance of accuracy in that regard.

It is certain that numerous species of fishes have been ascribed on erroneous information to the waters of the United States, by writers of authority. Such species should of course be dropped from the lists. Nor should any species be retained in regard to which any serious doubt exists. It is manifestly better that a chance visitor to our shores should be erroneously omitted, than that a species which has never been taken should be improperly inserted.

I give here the names of 35 species which should, in my opinion, be dropped from our lists of species inhabiting the waters of North America, north of the Tropic of Cancer. Most of these are admitted in Jordan and Gilbert's Synopsis of the Fishes of North America, but many of them are repudiated in the addenda to this work. I omit several species already expunged by earlier writers, and include only those which have lately had some degree of currency. I divide these into two series, as to whether the error is one as to locality or as to identification.

a. Species erroneously recorded as to locality.

1. **Carcharias isodon** Müller and Henle.

Originally described from a specimen from unknown locality collected by Milbert. As Milbert made some collections in New York, it has been assumed that this specimen came from New York, and that Mitchill's *Squalus punctatus* is the same species.

But Mitchill's shark was probably the *Carcharias terræ-novæ* of Richardson, and no recent collector has found *C. isodon* on our coasts.

2 **Carcharias punctatus** (Mitch.).

Described by Richardson as *C. terræ-novæ*, from a specimen brought by Audubon from Newfoundland. *Scorpæna bufo* C. and V. (= *S. plumieri* Bloch) and *Malthe cubifrons* Rich. (= *M. vespertilio*, var. *radiata* Mitch.) were in the same collection. Audubon collected in Southern Florida also: his accuracy in regard to localities is not above suspicion, and the three species in question belong to the fauna of the Florida Coast. There is not the slightest probability that any of the three came from the northern coast.

3. **Dules auriga** Cuv. and Val.

A South American fish, introduced in our lists by De Kay, from a specimen seen "several years ago in the collection of Mr. Hamilton, who informed me that it had been taken in the harbor of New York." This is not probable.

4. **Paranthias furcifer** (Cuv. and Val.).

(*Brachyrhinus creolus* [C. and V.] Gill.)

Described by De Kay under the name of *Corvina oxyptera*, from an old specimen in the cabinet of the New York Lyceum, "obtained from the adjacent coast." The specimen was probably from the West Indies, where the species is not uncommon.

5. **Epinephelus niveatus** Cuv. and Val.

A young specimen belonging (according to Goode and Bean) to this species, was described by Professor Gill (Proc. Ac. Nat. Sci. Phila., 1861, 98) under the name of *Hyporthodus flavicauda*. This specimen belonged to a collection sent to the Academy at Philadelphia by Mr. Samuel Powell, of Newport, Rhode Island. A list of this collection is given by Professor Cope (Proc. Ac. Nat. Sci. Phila., 1870, 118). Eleven species are included in it. All are represented by young specimens, which had probably not strayed far from the place where they were hatched. All of them are of tropical types; six of them have not since been found in the United States, and only two (*Caranx setipinnis* Mitch. = *Vomer curtus* Cope, and *Pseudopriacanthus altus* Gill) have since been seen on the New England Coast; while three others (*Hemi-*

rhamphus unifasciatus Ranz., *Glyphidodon saxatilis* L., and *Tetrodon testudineus* L.) are found on our Florida Coast.

Certainly it is very improbable that this collection was made at Newport, and I think that until good evidence appears that such was the case, the entire list should be erased.

6. **Polyprion americanus** (Bloch and Schneider).
(*Polyprion cernium* Val.)

Dr. Day says (Fish. Gt. Britain, etc., p. 17) of this species: "Forster recorded it from Queen Charlotte's Island on the Western shore of North America." The "Queen Charlotte's Island" referred to by Forster, lies, if I am not mistaken, in the neighborhood of New Zealand, and his *Perca prognatha* or *Epinephelus oxygenios* Bloch and Schneider is probably a species of *Stereolepis*; at any rate, not a *Polyprion*; *P. americanus*, however, has been taken in deep water off our Atlantic Coast.

7. **Rhypticus nigripinnis** Gill.
(*Promicropterus decoratus* Gill.)

A species belonging to the Pacific Coast of Tropical America. A specimen in the Powell collection above noticed, was identified with it by Professor Cope.

8. **Apogon americanus** (Castelnau).

A specimen in the Powell collection was identified with this species by Professor Cope. Castelnau's type came from South America. It was very imperfectly described and is in bad condition. Vaillant and Bocourt have identified the specimen somewhat doubtfully with *Apogon dovii*, a Panama species; what Professor Cope had is therefore very doubtful.

9. **Chætodon maculocinctus** (Gill).

Described from a very young fish in the Powell collection, and not since recognized.

10. **Scorpæna porcus** L.

A specimen in the Museum at Paris, said to have been brought by Milbert from New York, which is very improbable.

11. **Trigla cuculus** L.

A specimen in Paris, collected by Milbert with the preceding species. Both belong to the fauna of Southern Europe.

12. **Balistes powelli** Cope.

Described from the Powell collection; perhaps a young specimen of *Balistes carolinensis* Gmelin (= *B. capriscus* Gmelin).

13. **Tetrodon trichocephalus** Cope.

Described from the Powell collection; not since recognized.

14. **Ranzania truncata** (Retz).

Given in Jordan and Gilbert's Synopsis Fish. N. A. as "occasional off our Atlantic Coast." The specimen in question came from the Bermudas.

b. Species admitted through erroneons identifications.

1. **Galeus galeus** (L.).

Recorded from California by Dr. Günther and later by Jordan and Gilbert. Our specimens are since recognized as belonging to a distinct species, *G. zyopterus* J. and G.

2. **Carcharias plumbeus** Nardo.

(*Carcharias milberti* Val.)

One of the types of *Carcharias milberti* Val. came from Milbert's collection, "New York." The others were from the Mediterranean and belongs to the previously described *C. plumbeus.* Milbert's specimen was probably either *C. cœruleus*, or else from some other locality. In any event, *C. milberti* Val. should not have a place in our lists.

3. **Carcharias lamia** Risso.

First ascribed to our fauna by Putnam, from a tooth found on St. George's Banks; afterwards by Jordan and Gilbert from specimens taken at San Diego, California. The latter belong to distinct species (*C. lamiella* J. and G.). The species, however, occurs in abundance about the Florida Keys, and it should be retained in our lists.

4. **Isurus glaucus** Müller and Henle.

Our fish does not agree well with Müller and Henle's account of the East Indian *glaucus*. It is probably distinct and should stand as *I. dekayi* Gill.

5. **Isurus spallanzani** Raf.

Certainly not yet positively known from our coast. De Kay's *Lamna punctata* is *Isurus dekayi.* Storer's *Lamna punctata* is *Lamna cornubica.*

6. **Heptranchias indicus** (Cuvier).

The Californian species, *H. maculatus* Ayres, has been erroneously confounded with this East Indian shark.

7. **Pristis pristis** (L.).

There is no evidence of the occurrence of this species (*P. antiquorum* Latham) in American waters. All Atlantic specimens studied belong to *P. pectinatus* Latham; those from Panama to *P. perroteti* Val.

8. **Lepidosteus tristœchus** (Bloch).

Our Alligator Gar appears to be somewhat different from this Cuban species. Its oldest name is *Lepidosteus spatula* Lac.

9. **Muræna afra** Bloch.

The American species thus called by Günther and by Jordan and Gilbert does not appear to be identical with the African species called *Gymnothorax afer* by Bloch, which is described as "brunneo alboque marmorato." Our species should apparently stand as *Muræna funebris* (Ranzani). *Muræna infernalis* Poey is the same species.

10. **Ophichthys punctifer** Kaup.

The specimens from Pensacola recorded as *O. punctifer* or *mordax* Poey, belong to the species called *Ophichthys schneideri* by Steindachner. Possibly all three are identical.

11. **Sphyræna sphyrena** (L.).

Our small Northern Barracuda has been identified with this European species (*Sphyræna spet* Lac.) by Günther and later by Jordan and Gilbert. It is, however, I think, specifically distinct and should stand as *Sphyræna borealis* De Kay, as has been already indicated by Goode and Bean, and by Meek and Newland.

12. **Trachynotus goreënsis** Cuv. and Val.

The large pompano or "permit" of the Florida Keys and West Indies has been identified by Goode and Bean, following Dr. Günther, with the African fish indicated as *Trachynotus goreënsis*, by Cuvier and Valenciennes. There is, however, little reason for thinking this identification correct. On the other hand the young of the American "Permit" have been described by Professor Gill under the names *Trachynotus rhodopus* and *Trachynotus nasutus*. It should therefore stand as *Trachynotus rhodopus*, as lately noted by Meek and Goss. *Trachynotus carolinus* of Poey's memoirs is *T. rhodopus*. *T. kennedyi* Steindachner is a different species.

13. **Coryphæna equisetis** L.

All the dolphins thus far definitely known from our coast, under whatever names described, belong to *Coryphæna hippurus* L. The occurrence of *C. equisetis* is yet to be proven, although not improbable.

14. **Epinephelus acutirostris** (Cuv. and Val.).

It is probable that the specimen of this species, mentioned by Cuvier and Valenciennes as having been sent to Paris from Charleston by Holbrook, belongs to *Epinephelus microlepis* (Goode and Bean). This species differs from *E. acutirostris* in the much smaller scales, as well as in other respects. The specimens in the National Museum called *Trisotropis brunneus* Poey, by Goode and Bean, and afterwards made the types of *Trisotropis stomias* Goode and Bean, belong also to *E. microlepis*. The real *Trisotropis brunneus* Poey abounds, however, about the Florida reefs.

15. **Sciæna stellifera** (Bloch).

Sciæna lanceolata (Holbrook), the species found on our Carolina coast, is not identical with either the *Sc. stellifera* (or *trispinosa*) of Günther or of Steindachner. What species is the original of Bloch is certainly doubtful, as at least nine species of this type ("*Stelliferus*") occur in the waters of Tropical America, and Bloch's specimen was said to have come from Africa.

16. **Holacanthus tricolor** Bloch.

Inserted by Jordan and Gilbert (Synopsis, p. 941) as from the Florida Keys, on the statement of a collector. The specimens in question belong to *Pomacanthus aureus*.

17. **Pomacanthus arcuatus** L.

The specimen in the National Museum from Garden Key, Florida, referred to this species, belong to *Pomacanthus aureus* (Bloch). The latter species is abundant about the Florida Keys, but *P. arcuatus* is yet to be taken in our waters.

18. **Acanthurus phlebotomus** Cuv. and Val.

This is another species sent from New York to Paris, by that remarkable collector, Milbert. It is a West Indian species, not yet known from our coasts, unless it be identical with *A. chirurgus*, which is probable. The original *Chætodon nigricans* of L. was based on an old world specimen, and neither this nor any other American species should be called *Acanthurus nigricans*.

The only species of *Acanthurus* yet definitely known from the American coasts are *A. chirurgus*, *A. tractus* and *A. cæruleus*.

19. Cottus bubalis L.

This species has been ascribed to the fauna of Greenland, but, according to Lütken, it has not yet been found in that region.

20. Agonus cataphractus L.

Erroneously ascribed to Greenland, *A. decagonus* Bloch having been mistaken for it.

21. Prionotus punctatus (Bloch).

A common West Indian species, appearing in nearly all of our catalogues as a fish of our South Atlantic Coast. But I have seen no specimens from any point north of Cuba. It is probable that the very different species, *Prionotus scitulus* Jor. and Gilb., has been repeatedly recorded as *P. punctatus*.

22. Anoplarchus alectrolophus (Pallas).

Described from the Gulf of Penshin, and therefore not yet definitely known from Alaska.

23. Blennius fucorum Cuv. and Val.

Specimens of a Blenny found in the fucus in the open sea, outside of New York harbor, were referred by De Kay to this species. De Kay's description is taken from Cuvier and Valenciennes, and no evidence of the correctness of this identification appears In local lists, *Isesthes punctatus* Wood has appeared occasionally as *Blennius fucorum*.

24. Hippocampus hippocampus L.

(*H. heptagonus* Raf.; *H. antiquorum* Leach.)

A sea-horse from St. George's Bank has been identified with this European species by Mr. Goode. His description does not agree well with my European specimens, and I think that his fish must belong either to *H. hudsonius* or to some species as yet undescribed.

NOTES ON TERTIARY SHELLS.

BY OTTO MEYER.

In the Proceedings of the Academy of Natural Sciences, Phila., 1879, pp. 217–225, A. Heilprin gave in an essay, well worthy of perusal, a review of those species of the American Tertiary which had been hitherto compared and identified with European ones, and then identifies the following: [1]—

Cardita imbricata Lam. = *Cardita rotunda* Lea.
Cardita planicosta Lam. = *Cardita planicosta* Lam. (Conr.).
Corbis lamellosa Lam. = *Corbis lirata* Conr.
Trochita trochiformis Lam. = *Trochita trochiformis* Lea.
Cypræa elegans Defr. = *Cyprædia fenestralis* Conr.
Actæon simulatus Sow. = *Tornatella bella* Conr.
Niso terebellatus Lam. = *Pasithea umbilicata* Lea.

I have seen and examined many American species in the museums of New York and New Haven, but my observations are chiefly derived from material of my own collection, consisting of several hundred German Oligocene species in addition to numerous

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[1] Here are omitted all identifications, where Heilprin has any doubt, or which are not obtained by a direct comparison of specimens; of such are the following: –

Ostrea divaricata Lea, compared with *Ostrea flabellula* Lam.
Pecten Deshayesi Lea, " " *Pecten opercularis* Lam.
Cardium Nicolleti Conr., " " *Cardium semigranulatum* Sow.
Corbula oniscus Conr., " " *Corbula rugosa* Lam.
Cylichna galba Conr., " " *Bulla Brocchi* Bronn.
Tornatella pomilia Conr., " " *Tornatella inflata* Féruss.
Pyrula penita Conr., " " *Pyrula nexilis* Lam.
Cancellaria tortiplica Conr., compared with *Cancellaria evulsa* Brand.
Sigaretus declivus Conr., } " " { *Sigaretus canaliculatus*
Sigaretus bilix Conr., } { Sow
Solarium ornatum Lea, compared with *Solarium canaliculatum* Lam.
Pleurotoma nodo carinata Gabb, compared with *Pleurotoma denticula* Bast.
Mesostoma rugosa Heilpr., compared with *Mesostoma grata* Desh.
Melania Claibornensis Heilpr., " " *Melania mixta* Desh.

American ones. From these examinations I have been able to identify the following additional species :—

1. Cerithium trilineatum Phil.

?1832. *Cerithium turellum* Grat.
Grateloup, Tabl. des Coq. foss. du bassin de l'Ad. Act. Linn., v, 5, p. 277.

1836. *Cerithium trilineatum* Phil.
R. A. Philippi, Enumeratio molluscorum Siciliæ, etc., vol. i, p. 195, tab. 11, fig. 13.

1840. *Cerithium terebralis* Ad.
C. B. Adams, Descr. of thirteen new spec. of New England shells. Boston Journ. Nat. Hist., vol. iii, p. 320, tab. 3, fig. 7.

1841. *Terebra constricta* H. C. Lea.
H. C. Lea, Descr. of some new spec. of foss. shells from the Eocene of Claiborne, Ala.; Am. Journ. Sc. a. Arts, vol. xi, p. 100, tab. 1, fig. 18, read Oct. 1840, publ. 1841.

1843. *Cerithium trilineatum* Phil.
Philippi, Beitr. z. Kenntn. d. Tertiaerverstein. d. nordwestl. Deutschlands, p. 23, p. 56, p. 75.

1848 *Cerithium trilineatum* Phil.
Wood, Crag Mollusca, vol. i, p. 70, tab. 8, fig. 4 *a*.

1856. *Cerithium trilineatum* Phil.
Hœrnes, fossil. Moll. d. Tertiaerbeck. v. Wien, vol. i, p. 413, tab. 42, fig. 19.

1864. *Cerithium trilineatum* Phil.
Speyer, Tertiaerfauna v. Sœllingen, Palœontographica, vol. ix, p. 32.

1866. *Cerithium mundulum* Desh.
Deshayes, Anim. s. vertèb. du bassin de Paris, vol. iii, p. 222, tab. 79, fig. 31, 32.

1867. *Cerithium Sandbergeri* (v Koenen non Desh.).
v. Koenen, Marine Mitteloligocæn v. Norddeutschland, Palæontogr., xvi, p. 104.

1883. *Cerithium Sandbergeri* (Meyer non Desh.).
O Meyer, Beitr. z. Kenntn. der Maerk. Rupelthons, Ber. d. Senckenb. Naturforsch. Ges., Frankfurt a. M., 1882–1883, p. 261.

1883. *Cerithium Meyeri* (Boettg.) [no description given].
Lepsius, Mainzer Becken, p. 50.

1883. *Cerithiopsis Meyeri* Boettg.; *n. sp.*
Archiv des Vereins der Freunde der Naturgeschichte in Mecklenburg, 1883, p. 247.

—— *Terebra trilirata* Conrad. When and where?

Having seen *Cerithium trilineatum* Phil. occurring in the European and American older and newer Tertiary, as well as in the Mediterranean, I sought for it among the recent shells of the American Eastern coast, and have received, through the kindness

of Professor Verrill, specimens of *Cer. terebralis* Ad., which species was the looked-for identical one.

The description and figure of *Terebra constricta* H. C. Lea are poor, but there is no doubt about this determination of my specimens from Claiborne, which are quite identical with the German ones.

Among the synonyma, *Cer. mundulum* Desh. is given, although I have no specimens of this species; but I cannot find any difference to distinguish it from the figure and description given by Deshayes of *Cer. trilineatum*, and, as such a competent observer as Speyer has said the same, I do not think I have made a mistake.

Cer. trilineatum occurs in the American Miocene. I received one specimen of it labeled: " *Terebra trilirata* Conr.," but I could not find this name in any of Conrad's papers. Professor Heilprin writes to me: "Possibly it is one of the numerous forms that Conrad named without description."

If *Cer. trilineatum* Phil. should be identical with *Cer. turellum* Grat., of which I have no specimens, the latter name would have the priority.

Cer. trilineatum Phil. is generally distributed in the older and later Tertiary and also at the present time on both sides of the Atlantic.

2. Pleurotoma denticula Bast.

1825. Basterot, Descr. Géol. du bassin tert. sud-ouest de la France, p. 63, tab. 3, fig. 12.

1833. *Pleurotoma Baumonti* Lea.
I. Lea, Contrib. to Geology, p. 134, tab. 4, fig. 127.

1844. *Pleurotoma denticula* Bast.
Nyst. Descr. des. Coq. foss. de la Belg., p. 526, tab. 44, fig. 2.

1860. *Turris nodo-carinata* Gabb, fide Heilpr.
Gabb, Descr. of new spec. of Am. Tert. a. Cret. foss.; Journ. Ac. Nat. Sc. Philad., vol. iv, 2d series, p. 379, tab. 67, fig. 13.

1861. *Pleurotoma denticula* Bast.
Edwards, Monogr. of Brit. Eocene, p. 286, tab. 30, fig. 7 *a–h*.

1867. *Pleurotoma denticula* Bast.
v. Koenen, Mar. Mitteloligocæn, p. 89.

1879. *Pleurotoma denticula* Bast.
Heilprin, Proc. Ac. Nat. Sc. Philad., p. 214, tab. 13, fig. 10.

The last named author writes that he found *Pleur. denticula* Bast. in Claiborne sand. He figures a specimen without the upper part

of the spire and determined this species from descriptions and figures of European specimens. It is here only necessary to say that I concur in Heilprin's determination after having compared perfect shells from Claiborne with perfect German ones (Sternberger Oligocene). In my opinion a direct comparison of specimens is *conditio sine qua non* in the identification of species from both sides of the Atlantic.

The Claiborne specimens are apparently *Pleur. Baumonti* Lea, but the name of Basterot has the priority.

Pleur. denticula Bast., which occurs also in Italy, seems to be widely spread in the Tertiary.

3. Pleurotoma Volgeri Phil.

? 1804. *Pleurotoma terebralis* Lamarck.
Deshayes, Coq. foss. 1824-37, vol. ii, p. 455, tab. 62, fig. 14-16.

1846. *Pleurotoma Volgeri* Phil.
Philippi, Verzeich. d. in d. Geg. v. Magdeburg aufgef. Tertiaerverstein., Palæontographica, i, Aug. 1846, p. 69, tab. 10 *a*, fig. 2.

1847. *Pleurotoma cristata* Conr.
Conrad, Proc. Ac. Nat. Sc. Philad., iii, p. 284 (no figure).

1848. *Pleurotoma cristata* Conr.
Conrad, Journ. Ac. Nat. Sc. Philad., i, 2d series, p. 115, tab. 11, fig. 20.

1860. *Turris cristata* Conr.
Gabb, Journ. Ac. Nat. Sc. Philad., vol. ix, 2d series, p. 378, tab. 67, fig. 12, non fig. 8.

? 1861. *Pleurotoma Volgeri* Phil.
Edwards, Monogr. of the Eocene Moll. of England, p. 275, tab. 30, fig. 15 *a*, *b*, non fig. 13. (Publ. Paleontogr. Soc. London, issued as volume for 1858, publ. 1861.)

? 1861. *Pleurotoma terebralis* Lam.
Edwards, ibid., p. 233, tab. 27, fig. 10 *a*-*k*.

1865. *Cochlespira engonata* Conr.
Conrad, Am. Journ. of Conchology, i, p. 142, figure in the same volume, tab. 21, fig. 12.

1865. *Cochlespira bella* Conr.
Conrad, ibid., p. 210, tab. 21, fig. 6.

1867. *Pleurotoma Volgeri* Phil.
v. Koenen, Mar. Mitteloligocæn, Palæntogr., xvi, p. 92.

1867. *Pleurotoma Volgeri* Phil.
Speyer, Conchyl. d. Casseler Tertiaers, Palæontogr., xvi, p. 193, tab. 19, fig. 12 *a*, *b*.

1872. *Pleurotoma terebralis* Lam.
Koch und Wiechmann, Die Molluskenfauna des Sternberger Gesteins in Mecklenburg, p. 66.

With the German specimens of the Maerkische Rupelthon and the Sternberger Oligocene, two specimens from Ashley, S. C., one from the upper strata of Claiborne (which are apparently Oligocene), and one specimen of typical *Pleurot. cristata* Conr. from Vicksburg were compared. The latter was obtained for comparison through the kindness of Professor Heilprin of Philadelphia.

Both German and American forms vary in slenderness; *Cochlespira engonata* Conr. is apparently one of the shorter specimens. In the American forms the number and sculpture of the revolving lines seem to be generally more developed, but these vary too. Conrad says: "*Cochlesp. bella* differs from *C. cristata* in having fewer and coarser lines and a more prominent carina."

What Edwards figures as *Pleur. Volgeri* Phil. looks quite different. Much more like seems to be his *Pl. terebralis* Lam., of which he describes six varieties. The opinions of the German authors as to the identity of *P. Volgeri* Phila. and *P. terebralis* Lam. are varying. I am greatly inclined toward uniting them, but for want of sufficient material prefer withholding a positive opinion on this point.

4. Saxicava arctica L.

1766. *Mya arctica* L.
Linn., Syst. Nat. ed. 12, p. 1113.

1836. *Saxicava arctica* L.
Philippi, Enum. Mollusc. Sicil., etc., i, p. 20, tab. 3, fig. 3.

1838. *Saxicava bilineata* Conr.
Conrad, Medial Tertiary or Miocene fossils of the U. S., p. 18, tab. 10, fig. 4.

1844. *Saxicava arctica* L.
Nyst., Coq. foss. Belg., p. 95, tab. 3, fig. 15 *a*-*c*.

1846. *Saxicava arctica* L.
Lovén, Ind. moll. Scand., p. 40.

1848. *Saxicava arctica* L.
S. V. Wood, Crag. Moll., ii, p. 287, tab. 29, fig. 4 *a*, *b*.

1856. *Saxicava arctica* L.
Hoernes, Wiener Becken, p. 24, tab. 3, fig. 1, 3, 4.

? 1860. *Saxicava Jeurensis* Desh.
Deshayes, Anim. s. vertèb., i, p. 170, tab. 10, fig. 18, 19, 20.

1863. *Saxicava bicristata* Sandb.
Sandberger, Conchyl. d. Mainzer Beckens, p. 277, tab. 21, fig. 6.

1864. *Saxicava bicristata* Sandb.
Speyer, Tertiaerfauna v. Soellingen, Palæontogr., ix, p. 48.

1867. *Saxicava arctica* L.
Weinkauff, Conchyl. d. Mittelmeeres, i, p. 20.

1868. *Saxicava arctica* L.
v. Koenen, Marin. Mitteloligocæn, 2d part, Palæontogr., xvi, p. 266.

Two specimens of *Saxicava bilineata* Conr. from the American Miocene prove to be the same variety as *S. bicristata* Sandb.

Wood has already said in 1848 (Crag. Moll. p. 288): "*Saxicava bilineata* Conr. is probably another variety of this species" (*S. arctica*).

I cannot see in the figure of *S. Jeurensis* Desh. any difference from our species. V. Koenen seems to be of the same opinion.

Saxicava arctica L. seems to be generally distributed in the older and later Tertiary and in the present time on both sides of the Atlantic.

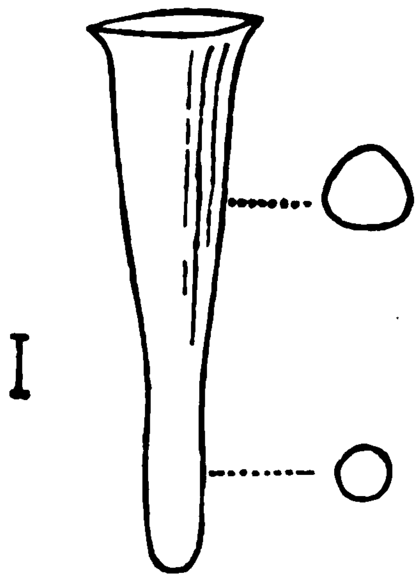
New species were found by me in Claiborne sand, belonging to the American Museum of Natural History in New York, and which had been examined several times before. Afterwards I received sand from Claiborne myself and found most of these species again, as well as others that are new. Only the three following species, however, are published here, chiefly because the state of the literature on North American Tertiary invertebrates makes it almost impossible to determine with certainty new species and to find and to describe the differences from similar forms, already named.*

* In White's Bibliography there are given nearly seventy papers of the main author of this literature, T. A. Conrad, containing notes on American Tertiary mollusks; and even this list is not complete. Conrad's description and figures are mostly poor or very poor. He published a great many fossils without figures, many without localities, and not a few without giving even the formation; I have also found one without a name (Proc. Ac. Phil., 1862, p. 288). In his two check-lists of the older Tertiary (1865 and 1866) he ignores the species of H. C. Lea, and does not give an account even of all his own. Having a tendency to describe a variety as a new species and a species as a new genus, he found, of course, that not only the Miocene species are all different from the Eocene ones, but that even the groups of the Am. Eocene "hold few, if any, species in common."

PTEROPODA.

Tibiella Marshi (nov. gen. et nov. spec.)*

Shell thin, tubular. The closed end little convex. The lower part, about one third of the whole length, of a circular section, then by tapering a little forming a kind of a neck, above which the shell is of a rounded trigonal section. Aperture dilated.



Length, 3½ mm.

Locality.—Eocene sand from Claiborne, Ala.

Remarks.—If the figured specimen is adult, in the young ones the apex may be perhaps acute and afterwards partitioned off, as in the genus *Triptera* Quoy et Gaimard (*Cuviera* Rang).

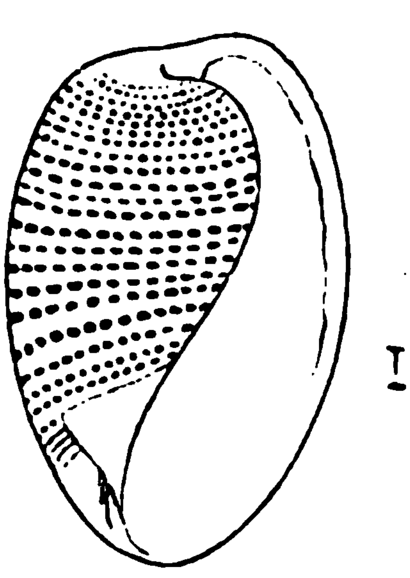
This genus is allied to *Tibiella*, and the latter is perhaps a subgenus of the former.

Pteropoda are described from the Miocene and Oligocene, but as far as I am acquainted with the literature this is the first Pteropod from the Eocene.

OPISTHOBRANCHIATÆ.

Bulla biumbilicata (nov. sp.).

Shell small, moderately thick, oval, the upper end obliquely truncated and umbilicated, the lower end somewhat tapering. Last whorl most prominent at about one-third of the whole length. Outer lip? Inner lip below with a large trigonal thin callus, which covers a minute umbilicus. Surface with revolving lines, disappearing at both ends and generally most distant from each other at about the middle of the shell. A strong magnifying glass shows that these lines are furrows, looking like pearl-ribbons, which structure causes the surface to look at some places as if it were minutely longitudinally costated.



Length, 2⅓ mm.

* Genus name from the resemblance to the tibia of mammals. This species is dedicated to Professor Marsh, who enabled me to work by supplying me from his library with a large part of the necessary literature, which I could not get elsewhere.

Locality.—Eocene sand from Claiborne, Ala.

Remarks.—One specimen, the outer lip of which is not quite perfect.

An allied form seems to be *Bulla Horni* Gabb, of Fort Téjon, Cal. (Gabb, Paleontology of California, vol. i, 1864, p. 143 [non p. 140], tab. 29, fig. 235), but this species is larger, thin, has no callus and seems to differ besides in form and sculpture. Gabb says: "Surface marked by numerous, very fine, impressed revolving lines."

Very similar is *Bulla ovulata* Lam. (Deshayes, Coq. foss. des env. de Paris, vol. ii, p. 39, tab. 5, fig. 13, 14, 15), but without callus.

Bulla subspissa Conr. (Proc. Ac. Philad., vol. iii, 1846, p. 20, tab. 1, fig. 29) from the Miocene of Calvert Cliffs, Md., seems to be of smooth surface; at least Conrad does not say anything about sculpture.

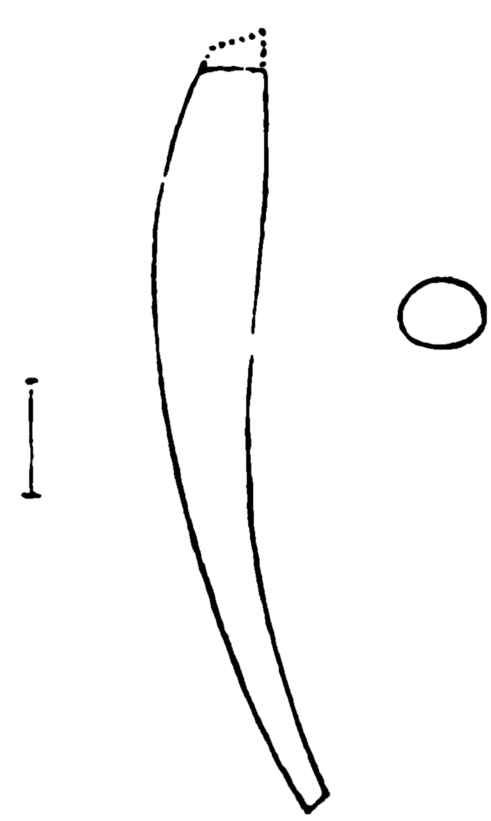
I cannot give the differences from *Bulla petrosa* Conr. (Am. Journ. Sc. a. Arts, vol. ii, 2d series, 1846, p. 399), as Conrad's full description of this shell is the following:—

"*Bulla petrosa.*—Oval, destitute of striæ ?, summit oblique."

GASTEROPODA.

Cadulus depressus (nov. sp.).

Smooth, shining, gently curved, inflation not very prominent. Section everywhere an oval, one side of which is a little flatter than the other. Both ends oblique.



Length, 7 mm.

Locality.—Eocene sand from Claiborne, Ala.

Remarks.—The aperture of the figured specimen is not perfect, but I know that it is of the form indicated in the figure, from other specimens. I have seen altogether about a dozen specimens, and all are everywhere of the same oval section.

There are to be compared three North American species of *Cadulus*:—

1. *Gadus pusillus* Gabb, of the Téjon group, Martinez, Cal. [Cretaceous or Tertiary ?] (Gabb, Paleont. of Cal., vol. i, 1864, p. 139, tab. 21, fig. 99). Gabb says: "section circular."

2. *Dentalium thallus* Conr., of the Miocene of the Southern States (Journ. Ac. Nat. Sc. Philad., vol. vii, 1st series, 1834, p. 142). The specimens of this species in my possession have a circular section, except at the aperture, where they are oval. It is the opinion of Professor Verrill and of myself, that *Cadulus Pandionis* Verrill and Smith (A. E. Verrill, Catal. of Mar. Moll., Transact. Connect. Ac., vol. v, part. 2, 1882, p. 558, tab. 58, fig. 30 *a*) of the western part of the Atlantic is identical with this *Cadulus thallus* Conr., although the latter form has the aperture generally a little more oval. If Jeffreys is right (J. G. Jeffreys, "On the Moll. of the Lightning and Porcupine expedition," part v) in uniting *Cadulus Pandionis* Verrill and Smith, with *Cadulus Olivi* Scacchi from the Pliocene of Sicily, it would result that both late Tertiary species are also identical, and this would be one more instance of a Tertiary species occurring on both sides of the Atlantic.

3. *Ditrupa subcoarcuata* Gabb, Eocene of Texas (Journ. Ac. Nat. Sc. Philad., vol. ix, 2d series, 1860, p. 386, tab. 67, fig. 47). The description of Gabb is the following: "Arcuate, widened in advance of the middle; aperture contracted, circular; surface polished." As Gabb does not say anything about an oval section, but on the contrary writes "aperture circular," it is apparently a different species.

APRIL 1.

The President, Dr. LEIDY, in the chair.

Thirty-one persons present.

A paper entitled "A Review of the American species of the Genus Trachynotus," by Seth E. Meek and David K. Goss, was presented for publication.

APRIL 8.

Rev. HENRY C. McCOOK, D. D., Vice-President, in the chair.

Seventy-three persons present.

A paper entitled "Descriptions of new species of Terrestrial Mollusca of Cuba," by Rafael Arango, was presented for publication.

Dr. Daniel G. Brinton was inaugurated as Professor of Ethnology and Archæology, and delivered a lecture on "Prehistoric Man in America."

APRIL 15.

Mr. CHAS. P. PEROT in the chair.

Twenty-four persons present.

A paper entitled "A Review of the American species of the Genus Synodus," by Seth E. Meek, was presented for publication.

On the Process of Digestion in Salpa.—Dr. CH. S. DOLLEY remarked that preliminary to giving the full results of a somewhat extended study of the histology of *Salpa*, he desired to make a few remarks in reference to certain statements recently made by Dr. A. Korotneff of Moscow,[1] which he considered erroneous in so far as they indicate the presence of a huge amœboid cell or plasmodium, in the œsophagus and stomach of *Salpa*, functioning as a digestive organ. Dr. Korotneff describes this cell as arising from the repeated division of a single cell which early in the life-history of the animal is separated from the intestinal wall. This giant-cell or plasmodium, acting like a huge rhizopod, carries on

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[1] *Ueber die Knospung der Anchinia* in Zeitschr. f. wiss. Zoologie. Bd. 40, Hft. i, 1884.

a form of parenchymatous digestion of the food taken by the animal, passing the resulting chyle into the walls of the intestine by means of its pseudopodia. Now by reference to an article by Metschnikoff "On Intracellular Digestion in Invertebrates" (in the Quarterly Journal of Microscopical Science for January, 1884), it will be seen that such a form as Korotneff describes has never been met with, and his description stands alone and anomalous, both as regards the situation and size of the digestive plasmodium, and as to the method of its formation, for in all cases in which such structures have been found in invertebrates, they have always arisen by the fusion of separate cells, not from the repeated division of one cell. In a large number of series of sections made by the new "ribbon" method, the speaker was not only unable to find "the lumen obliterated" by the peculiar structure of the wall of the intestine described by Korotneff, but in a model of the visceral nucleus made after Born's "platten-modillir method" the lumen of the entire intestinal canal is shown to be completely free throughout. He did, however, get sections which gave pictures almost identical with those portrayed by Korotneff, *i. e.* the lumen filled with what he describes as a large nucleated granular cell, containing various food particles, and he could trace this so-called "cell," not only back into "the portion of the intestine lying next to the stomach," but through the rectum into the cloacal chamber, and through the œsophagus into the branchial sac. He accounts for it as follows: The endostyle of *Salpa* has been very carefully studied by Hermann Fol, who demonstrated, by means of carmine suspended in water, that it threw out a constant stream of mucus when excited by the presence of nutritive material in the same water, with a reflex action like a salivary gland. The mucus is, by an arrangement of cilia, spread out like a curtain over the inner surface of the branchial sac, when it acts as a means for catching the food particles from the ingurgitated water. By the action of ciliary bands bordering the groove of the endostyle, the mucus is swept towards the œsophagus, and as it approaches this, it is, by means of the stiff cilia on the sides of the gill, twisted into a thread, and carried by a continuation of the aforesaid bordering bands, through the œsophagus, into the stomach. Now in studying a series of sections of a Salpa which had had abundant food, we find as we approach the œsophagus a mass of material answering to the description of Korotneff's "rhizopod." It takes staining readily and may be traced backward into and through the œsophagus, stomach and intestine. As the sections approach the rectum, however, the mass gradually ceases to take staining, and is much more distinctly marked out from the intestinal wall, having had all the organic matter digested out, and consisting only of the inorganic remains, which do not stain. The alimentary matter of Salpæ is composed of animal and vegetal elements in nearly equal proportions, and the microscope reveals the cal-

careous shells of Foraminifera, the beautifully sculptured frustules of Diatomaceæ, keen siliceous needles, and the sharp armatures of minute crustacea.

In the fore-part of the intestinal canal, the food mass, staining almost as readily as the wall of the gut itself, seems to merge into the ill-defined epithelium of the latter, and it is scarcely possible to say where the food-bearing mucous thread ceases and the intestinal epithelium begins, especially as this latter has a rugous arrangement. That we have here to do with a form of digestion entirely anomalous and unprecedented, he could not believe, and must beg leave to differ from Dr. Korotneff on this point. Fol and others have recognized the endostyle as a sort of salivary gland, and have traced its food-laden mucous thread into the stomach of the living animal, while the speaker had been able to trace the same thing in well-preserved specimens. He had also several series of sections from animals which must have been without food for some time previous to death, in which the lumen of the intestine is not only free of food, but of any obliterating mass of cells, or plasmodium. The only protoplasmic bodies not food, are certain Gregarina-like organisms adhering to the walls of various parts of the intestine, and which he took to be parasites. These give on section the appearance of the large "scattered cells, entirely free from their surroundings" which Korotneff figures and regards as "analogous to the great stomach-cell of *Anchinia.*" The first opportunity would be taken to examine these structures in living Salpæ, but he was now forced to conclude that Dr. Korotneff has endowed the food-bearing mucous thread with a power it does not possess, that *Salpa* does not exhibit any unusual form of intracellular digestion, and that there is no immediate cause on its account for questioning the high genetic place occupied by the Tunicates.

A Preliminary Note on a Reaction common to Peptone and Bile-salts.—Dr. N. A. Randolph stated that if the acid nitrate of mercury (Millon's reagent) be added to a cold aqueous solution of potassium iodide, a *red* precipitate of mercuric iodide always appears. When, however, either peptones or the biliary salts are present in noteworthy amount, the precipitate of nascent mercuric iodide assumes the *yellow* phase. As practically applied, the red may vary from salmon to scarlet, the yellow from pale lemon to orange.

In order to render the test sensitive to the presence of minute quantities of the substances in question, he had found it necessary to limit the amount of potassium iodide employed. Thus to each five cubic centimetres of the suspected fluid—which must be cold and either neutral or faintly acid—are added two drops of a saturated solution of potassium iodide, the two liquids being well mixed. Four or five drops of Millon's reagent are now added, the contents of the vessel thoroughly stirred or shaken. Under these

circumstances the presence of peptone in amounts of less than one part in five thousand is readily shown. By the exercise of great care in the performance of this test he had been enabled to demonstrate the presence of peptone in a solution containing but one part of that body in seventeen thousand parts of water.

The conditions interfering with this reaction are: alkalinity of the fluid examined (readily overcome by neutralization); heat, which has the same influence upon the nascent mercuric iodide as have peptone and the bile-salts; and the presence of certain compounds, as potassium ferrocyanide, which chemically prevent the production of the mercuric iodide.

The reaction just described presents certain advantage from the fact that it is uninfluenced by the bodies usually found in the various organic fluids. It is efficient in the presence of a twenty per cent. solution of serum; the presence of considerable amounts of coagulated albumen and of acid-albumen does not interfere with the test. The following bodies in moderate amount do not affect the reaction: Saliva, Syntonin, Amygdalin, Para-Albumen, Diastase, Kreatin, Leucin, Pyrosin, Mucic Acid, Glucose, Urea, Uric Acid, Nitric, Hydrochloric, Sulphuric and Picric Acids, Glycerine, Alcohol, Atropia Sulphate, Pilocarpin Nitrate, Caffeine, Sodium Carbonate, Ammonium Oxalate, Sodium Phosphate, and Manganese Chloride and Ferric Chloride.

It is obvious that this reaction is useless to the student as an isolated test, inasmuch as it responds to two entirely distinct compounds, but its simplicity and striking colorations give it very considerable value when employed in corroboration of other tests.

Botanical Notes.—At the meeting of the Botanical Section on April 14, Mr. THOMAS MEEHAN made some observations on the following topics:—

Evolution of Heat in Plants.—Referring to some observations of Kerner respecting the thawing out of chambers in ice by living plants in the Alps of Europe, he confirmed them by observations on *Eranthis hyemalis* made during the past winter. At the end of January the plant was in flower after a few warm days, when a driving snow-storm prostrated the little stems, and covered them nearly a foot deep, in which condition they remained till early in March. After they had been three weeks in this condition, the snow was carefully removed, when it was found that the stems had become perfectly erect, and a little chamber in the snow had been thawed out about each flower-stem. There was, however, no other evidence of growth. The few buds which were unopened when the snow came, were still unopened when the snow thawed away, after five weeks' imprisonment; and the idea conveyed was that plants would retain life, without growth, for an indefinite time, when under a low temperature, such as a covering of ice or snow afforded.

Relation of Heat to the Sexes of Flowers.—He referred to his former communications to the Academy regarding his discovery that the male flowers or male organs of flowers entered on active growth at a much lower temperature than excited the female, and exhibited catkins and female flowers of the European hazel-nut, *Corylus Avellana*, just matured April 15, and which, for the first time in several years past, had perfected themselves cotemporaneously. This was the first winter for some time that there had been a uniform low temperature the whole season. In other years a few warm days in winter would advance the male flowers so that they would mature weeks before the female flowers opened, hence the females were generally unfertilized, and there were few or no nuts. Under this law it was evident amentaceous plants could not abound to any great extent in countries or in localities favorable to bringing forward the male flowers before there was steady warmth enough to advance the female. He thought this was likely to be the reason why so many coniferous trees under culture in the vicinity of Philadelphia bore scarcely any fertile seed in their cones—a fact which had often been remarked in connection especially with the Norway spruce. The male flowers would mature before the female had advanced far enough to be receptive of the pollen,

Specific Differences in Picea nigra.—It was regarded as somewhat difficult to distinguish between the red and black spruces. Mr. Meehan exhibited authentic specimens of these and the white spruce, and pointed out the persistent character of the cones in *Picea nigra*, to which his attention had been called by Mr. Robt. Douglas, of Waukegan, Illinois. They were still attached to the branches exhibited.

The Flowers of Platanus.—Having an opportunity to examine a large tree of *Platanus occidentalis*, no exception could be found to the rule that the pedicel proceeded from the third node in the season's growth. It appeared also that in the formation of the pedicel, the growth of the branch was always almost arrested—but not sufficiently so but that it seemed to recover and make a second growth. In many cases the annual growth was completely suppressed, and only a terminal bud was formed just above the axis of the pedicel; but in most cases, another or secondary growth followed the first temporary check and a shoot of several nodes would be formed beyond the point of departure of the pedicel. The same rule prevailed in *Platanus orientalis*.

Variation in Symplocos fœtidus.—Mr. Meehan had made it a point for some years to take, as opportunity offered, some genus of only a single species within a large range of territory, and note the variation therein. In this way we could often see a vast amount of variation, which could not be started by any hybridization with other forms, but which must have been produced by some law of evolution within itself. Even though one might believe himself to be quite familiar with the skunk cabbage,

Symplocos fœtidus, he would be surprised at the great amount of variation it presented, even in a small area, when the variations were looked for by comparison. He had himself seen a plant bearing spathes four inches long, with its next neighbor having one a little over an inch—no larger than a walnut. Some would be globular, some ovate, some linear, some terminating in an abrupt point, others lengthened into a long straight or curved beak. The variations in color were too well known to need more than this bare reference. It was not uncommon to hear variation attributed to environment, by which we are to understand external, and in a measure accidental circumstances. Environment might be led to include some external influence operating on the primary cell, giving birth to the subsequent individual exemplifying the variation.

But in this sense, change by environment would be the merest guess, as no evidence had been offered in support of any special influence then not exerted. At other times no great variation followed, and possibly no one would want to embrace this point in a definition of environment.

Sugar in Cladastris tinctoria.—In Mr. Meehan's garden at Germantown, there were few trees but which exuded sap from wounds made in winter or early spring, but among them all, few bled, as it was termed by horticulturists, more profusely than *Cladastris tinctoria* (*Virgilia lutea* Mx.). The icicles formed from this exuding sap afforded a good opportunity to test the saccharine character of the liquid. During congelation by frost all foreign substances are rejected, and in the formation of the icicle the sugar is pushed forward to the extreme point. The end of an icicle of a sugar maple is its only sweet part, and this was very sweet from the accumulation of the saccharine matter. The end of the icicle from the *Cladastris* was also sweet, though less so than in any other sugar-bearing trees he had observed.

APRIL 22.

The President, Dr. Jos. LEIDY, in the chair.

Twenty-eight persons present.

Vertebrate Fossils from Florida.—Prof. LEIDY directed attention to some fossils, part of a collection recently referred to him for examination by the Smithsonian Institution. They consist of remains mostly of large terrestrial mammals, especially related with forms which now live in the intertropical portions of the old world. Obtained in Florida, they are of additional interest as evidences of the existence in this region of a formation of tertiary age not previously known. An accompanying letter from Dr. J. C. Neal, of Archer, Florida, informs us that the fossils

were discovered in a bed of clay, occupying a ridge in the pine forest. They occurred over an irregular area of one hundred feet long by thirty feet wide, and were dug from variable depths of seven feet to the bed-rock, the character of which is not stated. The fossils, consisting of bones and a few teeth, are mostly in fragments, but exhibit no appearance of being water-worn, or abraded by friction among gravel. In the collection, for the present hastily examined, there may be observed the following more conspicuous remains:—

1. Those of a young mastodon, consisting of bone fragments and detached epiphyses. The epiphysial head of a femur measures 6¼ inches in diameter. In the clay adherent to the rough under surface, the vertebra of a teleost. fish is imbedded. An astragalus measures 4½ inches fore and aft, and 5½ inches transversely.

2. Remains, apparently of several individuals of a rhinoceros, rather smaller than the Indian rhinoceros. Among them are small fragments of a mandible, and portions of lower molar teeth. The nearly complete crown of one of the latter measures 2¼ inches fore and aft, with 1¼ inches width in front. The limb bones indicate an animal of shorter stature, but equally robust proportions to those of the Indian rhinoceros. There are two nearly entire radii, 9 inches long, by 3½ inches width at the proximal, and 3¼ inches width at the distal end. The distal extremity of a femur measures 6 inches at the epicondyles. The head of a tibia is 5¼ inches wide and 3½ inches fore and aft. A calcaneum is 5 inches long. Three middle metacarpels exhibit the following measurements:—

Length, . . .	4½ inches,	4 inches,	3¾ inches.
Width, proximal end,	2¾ "	2½ "	2¼ "
Width, distal end, .	2½ "	2¼ "	2⅛ "

3. Small fragments of the maxillæ of a tapir; one with an entire molar tooth, which differs neither in form nor size from the corresponding tooth of the living *Tapirus americanus*. The tooth measures 11 lines fore and aft by 13 lines transversely.

4. Remains, apparently of a llama, as large as the camel. The distal end of a metacarpel is about 4 inches in breadth. A first phalanx is 4½ inches long by 2¼ inches wide at the proximal end and 1⅝ inches at the distal end.

5. A calcaneum of a ruminant, not quite so long as that of the Irish elk, but of more robust proportions. Its reference is uncertain, and it is doubtful whether it pertains to the extinct *Cervus americanus*.

6. The vertebral centrum of a small crocodile.

7. Remains of several other animals undetermined.

APRIL 29.

The President, Dr. LEIDY, in the chair.

Twenty-seven persons present.

A paper entitled "New Fossils from the four groups of the Niagara Period of Western New York," by Eugene N. S. Ringueberg, was presented for publication.

On the Digestion of Raw and of Boiled Milk.—Dr. N. A. RANDOLPH referred to certain profound changes produced in milk by boiling. In this operation the casein is not coagulated, but there is an evolution of sulphuretted hydrogen (Schreiner), a diminution in the gaseous constituents of the fluid and a change in the amount of ozone present.

The most striking difference between raw and boiled milk lay in their respective responses to rennet, acids and alkalies.

At the body-temperature the firm coagulation of raw milk occurred almost immediately upon the addition of a neutral rennet solution, whereas boiled milk, under the same conditions, did not clot for a far longer period, and the coagula were not firm. On the other hand. dilute or strong acids were tenfold as active upon boiled as upon raw milk. Some time after making these experiments Dr. Randolph found that so far as acids and rennet were concerned, similar results had been obtained by Schreiner (Chem. Centralbl., III. Folge, IX. Jahrg.), and he desired to present his observations in these particulars simply as confirmatory of those of that observer.

Upon the addition of dilute alkalies to boiled milk, the rise of cream was much more rapid and complete than in raw milk under the same conditions.

Artificial digestions showed that milk was more readily digested when raw than when boiled. This was further confirmed by a comparative examination and weighing (in over fifty cases, and in which he was aided by Dr. Roussel) of the contents of the stomach after raw and boiled milk had been, in different individuals, undergoing actual gastric digestion. In these cases the residue found in the stomachs of those persons receiving boiled milk was greater than the similar residue found in the stomachs where raw milk had been undergoing digestion for the same length of time.

The following were elected members: Messrs. J. L. Forwood, L. Woolman, John Eyerman, Edw. Jackson, E. J. Wheelock and Miss S. D. Atkinson.

Ernest André, of Gray, Haute Sâone, France, was elected a correspondent.

The following were ordered to be printed:—

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS TRACHYNOTUS.

BY SETH E. MEEK AND DAVID K. GOSS.

In the present paper we give the synonymy of the species of *Trachynotus* found in American waters, with brief descriptions of those known to us found on the Atlantic Coast. The latter are here all described from specimens obtained by Professor Jordan at Havana and Key West. We are very much indebted to Professor Jordan for use of his library and for valuable aid.

In the following analysis of species, *Trachynotus marginatus* is omitted, the original description being too insufficient for comparison. Of the remaining seven species, two (*rhomboides*, *glaucus*) appear to be confined to the Atlantic; two others (*kennedyi*, *fasciatus*) represent those on the Pacific Coast, while the others (*rhodopus*, *carolinus*, *cayennensis*) appear to be found on both sides, although in the case of *rhodopus* and *carolinus* being far more abundant in the Atlantic.

Analysis of Species of Trachynotus.

a. Dorsal with 19 to 20 soft rays; anal with 17 to 19 soft rays.
- *b.* Body very much compressed; sides with narrow black cross-bars; lobes of vertical fins elongate, reaching past middle of caudal fin in adult.
  - *c.* Snout subtruncate or nearly vertical; profile from supraorbital to front of dorsal fin convex. *glaucus.* 1.
  - *cc.* Snout low, very oblique; profile from supraorbital region to the dorsal scarcely convex. *fasciatus.* 2.
- *bb.* Body moderately compressed; sides without narrow black cross-bars; lobes of vertical fins shorter, rarely reaching base of caudal; lobes of dorsal and anal usually blackish.
  - *d.* Body broad, ovate; the greatest depth at all ages more than half length of body; lobes of the vertical fins reaching in the adult beyond the middle of their fins.
    - *e.* Axil with a large black spot (in the adult); profile strongly convex anteriorly. *kennedyi.* 3.
    - *ee.* Axil without dark spot; profile from nostril to dorsal everywhere about equally convex. *rhomboides.* 4.

dd. Body oblong; the depth in young and old about $\frac{2}{5}$ length of body. *rhodopus.* 5.

aa. Dorsal with 25 to 27 soft rays; anal with 22 to 26 soft rays; body oblong, rather robust; greatest thickness 3 in greatest depth of body; depth less than half length; lobes of vertical fins short, not black; sides without dark cross-bars.

f. Dorsal with 25 soft rays; anal with 22 soft rays; profile from snout to procumbent spine evenly convex. *carolinus.* 6.

ff. Dorsal with 27; anal with 26 soft rays. *cayennensis.* 7.

Trachynotus glaucus. *Gaff-top-sail Pompano. Old wife.*

Chætodon glaucus Bloch, Ichthyologia, Pl. ccx, about 1783 (on a figure by Plumier).

Acanthinion glaucus Lacépède, iv, 1803, 500 (copied).

Trachinotus glaucus Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 400 (Brazil, Havana, Mexico, San Domingo, Martinique and Guadeloupe); Guichenot, "Poiss. Ramon de la Sagra, Hist. Cuba, 107, 1845" (Cuba).

Trachynotus glaucus Günther, Cat. Fishes Brit. Mus., ii, 1860, 483 (Antilles, Jamaica and Rio Janeiro); Gill, Proc. Acad. Nat. Sci. Phila., 1862, 438 (Charleston, S. C.); Gill, Rep. U. S. Fish Com., 1871–2, 803 (name only); Goode, Proc. U. S. Nat. Mus., 1879, 112 (name only); Goode, Bull. U. S. Fish Com., 1881, 37, 40 (Bermudas); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237 (name only); Jordan & Gilbert, Proc. U. S Nat. Mus., 1882, 270 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 1882, 443; Jordan & Gilbert, *op. cit.*, 912.

Habitat.—Atlantic Coasts of America: Charleston, Pensacola, Key West, Bermudas, Jamaica, Antilles, Guadaloupe. Martinique and Rio Janeiro. Also erroneously ascribed (by confusion with *Trachynotus fasciatus*) to Lower California and Panama.

Head 4 in length of body; depth 2; D. VI–I, 19; A. II–I, 18; length (No. 440, I. U. Key West) 13 inches.

Body elliptical, much compressed; snout blunt, subtruncate, vertical from mouth to horizontal from upper edge of eye; the profile from supraorbital to front of dorsal fin convex; eye $3\frac{2}{3}$ in head; mouth nearly horizontal; maxillary nearly reaches vertical from middle of eye, its length 3 in head; jaws without teeth in the adult; dorsal spines separate, in the adult; dorsal and anal fins falcate, the anterior soft rays reaching middle of

caudal fin; dorsal lobe 1½, anal 1¾ in length of body; ventrals reaching ½ distance to vent, their length 2⅝ in head; caudal very deeply forked, their lobes nearly half length of body. Color bluish above, golden below; lobes of dorsal and anal very dark, rest of the fins pale, with bluish edges; caudal bluish; Pectorals golden and bluish; ventrals whitish. Body crossed by four black vertical bands; the first is under the procumbent spine, the second under the third dorsal spine, the third and fourth under the soft dorsal. A black spot, representing a fifth band, on latter line between the last rays of dorsal anal; this is sometimes obsolete; the position of these bands appears to be subject to slight variation. The young of this species has not yet been described.

Trachynotus fasciatus.

Trachynotus fasciatus Gill, Proc. Acad. Nat. Sci. Phila., 1863, 86 (Cape San Lucas); Günther, Fishes Cent. America, 1869, 434 (Panama, San Jose and Nicaragua); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 232 (Porto Escondido, Mexico); Jordan & Gilbert, Bull. U. S. Fish Com., 1882, 106 (Mazatlan, no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 359 (Cape San Lucas, no description).

Trachynotus glaucoides Günther, Proc. Zool. Soc., 1864, 150 (San Jose; Nicaragua).

Habitat.—Pacific Coast of Tropical America: Cape San Lucas, Mazatlan, Porto Escondido, San Jose, Nicaragua, and Panama.

This species is the Pacific representative of *Trachynotus glaucus*, which species it strongly resembles. The difference in the profile is, however, constant and characteristic.

Trachynotus kennedyi.

Trachynotus kennedyi Steindachner, Icht' yol., Beiträge, ii', 1875, 47, Pl. v.i, (Magdalena Bay); Günther, Fish. Cent. Amer., 1869, 388 (in part, Panama).

Trachynotus ovatus Lockington, Proc. Cal. Acad. Nat. Sci., 1876, 4 (Lower California); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 375 (Panama, not of Cuv. & Val.).

Trachynotus rhomboides Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 625 (Panama, young).

Trachynotus rhodopus Jordan & Gilbert, Bull. U. S. Fish Com., 1882, 106 (Mazatlan, not of Gill).

Habitat.—Pacific Coast of Tropical America: Magdalena Bay, Mazatlan, Panama.

This species is the Pacific Coast representative of *Trachynotus rhomboides*, from which it differs in the presence of a black axil-

lary spot, and slightly in form of the profile. The young lack this spot, and cannot readily be distinguished from the young of *Trachynotus rhomboides.* It is therefore probable that all the references made by authors to the occurrence of *T. rhomboides* (*ovatus*) on the Pacific Coast of Tropical America refer to this species. A series brought by Professor Gilbert from Panama (now unfortunately destroyed) is said to render this view very probable. We are informed by Professor Jordan that the specimens brought by Professor Gilbert from Mazatlan, recorded as *T. rhodopus*, belong to this species, of which the latter cannot be the young, as was at first supposed.

Trachynotus rhomboides. *Round Pompano; Palometa.*

Chætodon rhomboides Bloch, Ichthyologia, ccix, about 1783 (on a drawing by Plumier); Gmelin, Syst. Nat., 1788, 1259 (copied).

Acanthinion rhomboides Lacépède, Hist. Nat. Poiss., iv, 1803, 500 (copied).

Trachinotus rhomboides Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 407 (Martinique); Guichenot "Poiss. Ramon de la Sagra, Hist. Cuba, 1845, 108" (Cuba).

Trachynotus rhomboides Lütken, Spolia Atlantica, 1880, 602 (West Indies); Jordan & Gilbert, Syn. Fish. N. A., 1882, 974.

Spinous dory Mitchill, Trans. Lit. and Phil. Soc., 1815, Pl. vi, f. 10 (no description).

Trachinotus fuscus Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 410 (Brazil).

Trachinotus spinosus De Kay, N. Y. Fauna Fishes, 1842, 117, Pl. xix, fig. 53 (New York Harbor); Storer, "Syn. Fish. N. A., 1846, 98."

Lichia spinosus Baird, Ninth Smithsonian Rep., 1854, 22 (Beesley's Point, New Jersey).

Doliodon spinosus Girard, U. S. and Mex. Bd. Surv., 1859, 22 (St. Joseph's Island, Texas); Gill, Cat. Fish. East Coast N. A., 1861, 37 (name only).

Trachynotus ovatus Günther, Cat. Fish. Brit. Mus., ii, 1860, 481 (in part, West Indian specimens, apparently not *Gasterosteus ovatus*, which is the Asiatic species); Gill, Proc. Acad. Nat. Sci. Phila., 1862, 438; Gill, Proc. Acad. Nat. Sci. Phila., 1863, 332; Gill, Rep. U. S. Fish Com., 1871–2, 803; Baird, Rep. U. S. Fish Com., 1871–2, 825 (Wood's Holl, Mass.); Goode, Proc. U. S. Nat. Mus., 1879, 112 (name only); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 376 (Beaufort, N. C., no description); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 339 (Marquesas Keys, Fla.); Goode, Bull. U. S. Fish Com., 1880, 24 (name only); Goode, Bull. U. S. Fish Com., 1881, 36–39; Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237 (name only); Jordan & Gilbert, Syn. Fish. N. A., 1882, 442.

Habitat.—Atlantic Coast of America: Wood's Holl, New York,

Beesley's Point, Beaufort, Marquesas Keys, Key West, St. Joseph's Island, Martinique, and Brazil.

/Head $3\frac{3}{4}$ in length; depth $1\frac{3}{5}$; D. VI–I, 19; A. II–I, 18; length (No. 486, I. U. Havana) 18 inches.

Body broadly ovate, moderately compressed; profile very evenly convex from procumbent spine to horizontal from upper edge of eye, where it descends almost vertical. The vertical portion is about $1\frac{1}{3}$ times the eye; length of snout nearly equals the eye; mouth nearly horizontal; maxillary reaching to the vertical from middle of eye, its length $2\frac{2}{3}$ in head; jaws without teeth in adult; dorsal spines short and thick, not connected by membrane in adult; ventrals short, their tips scarcely reaching half way to anterior anal spine; 3 in head; caudal widely forked; lobes about $2\frac{2}{3}$ in length of body; dorsal and anal fins falcate; anterior rays reaching almost to posterior end of fins; in adults, dorsal lobe $2\frac{2}{3}$, anal lobe $4\frac{1}{2}$, in length of body. Color bluish above, silvery below; lobes of dorsal black in young; in adults the fins are all bluish with lighter tips.

The young differ from the adult as above described in the following respects: The profile is scarcely convex; snout shorter and less vertical; spines much longer and connected by membranes; lobes of vertical fins shorter; dorsal lobe with black; fins all much paler; jaws with bands of villiform teeth; eye larger; color much paler.

We have had no opportunity of comparing the American *Trachynotus rhomboides* with the East Indian *Trachynotus ovatus* with which it has been identified by Dr. Günther. We have been led to consider them as distinct by the following observation of Dr. Lütken: "I will only remark that the *Trachynotus rhomboides* of the Antilles has already its rhomboidal physiognomy and the falcations of its fins strongly prolonged at an age at which, in the *Trachynotus ovatus* of the seas of the Indies, these prolongations of the fins are quite short. I am of the opinion (with Mr. Gill) that these two species ought, at least provisionally, to be considered as distinct."

As the antecedent probabilities are against the identity of these species in such widely separated faunæ, there is less danger of confusion in regarding the two as different.

Trachynotus rhodopus. *Permit. Great Pompano.*

Trachynotus goreensis Günther. Cat. Fish. Brit. Mus., 1860, 483 (specimens from Caribbean Sea; in part, not of Cuvier & Valenci-

ennes); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 129 (West Florida, Jupiter's Inlet); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 339 (West Florida, Marquesas Keys); Goode, Proc. U. S. Nat. Mus., 1879, 112 (name only); Goode, Bull. U. S. Fish Com., 1881, 36, 40 (Key West and Jupiter's Inlet); Goode, Bull. U. S. Nat. Mus., 1880, 24 (name only); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237 (name only); Jordan & Gilbert, Syn. Fish. N. A., 1882, 442; Jordan & Gilbert, *op. cit.*, 1882, 974.

Trachynotus rhodopus Gill, Proc. Acad. Nat. Sci. Phila., 1863, 85 (Cape San Lucas; young).

Trachynotus nasutus Gill, Proc. Acad. Nat. Sci., 1863, 85 (Cape San Lucas; very young).

Trachynotus carolinus, Poey, Syn. Pisc. Cubensium, 1868, 371 (Cuba); Poey, Enumeratio Pisc. Cubensium, 1875, 86.

Habitat.—Both coasts of Tropical America: West Florida, Jupiter's Inlet, Marquesas Keys, Key West, Cuba, Caribbean Sea, Cape San Lucas.

Head 3 in length; depth $2\frac{3}{5}$: D. VI–I, 19; A. II–I, 17; length of specimen described (Key West), $2\frac{1}{3}$ inches.

Body oblong, elliptical, moderately compressed; profile nearly straight from procumbent spine to nostril, where it descends nearly vertical, forming an angle; vertical portion from angle to snout nearly equals the eye; maxillary reaches slightly behind vertical from middle of eye, its length $2\frac{3}{5}$ in head; jaws with bands of villiform teeth (these disappearing with age); ventrals reaching $\frac{3}{4}$ distance to vent, their length 2 in head; tips of pectorals reaching slightly past tips of ventrals; dorsal spines connected by a membrane, which is only characteristic of the young. Dorsal and anal fins falcate, their anterior soft rays less elevated than in *Trachynotus rhomboides*, but extending beyond middle of fins when depressed. Length in the young 4 in length of body; caudal forked, lobes about 3 in body; lateral line nearly straight, slightly curved upwards above the pectorals; color bluish silvery above, silvery below; dorsal, caudal and anal lobes blackish; no crossbars.

This species grows to a much larger size than any other of the genus found in our waters; specimens of 2 to 3 feet in length being not uncommon in Florida and Cuba. It has been identified with the *Trachynotus goreënsis* of Cuvier & Valenciennes, by
& Bean ~~most Amer~~ican authors, this being a species from the West Coast of Africa. The basis of this identification appears to be insufficient. According to Cuvier & Valenciennes this *Trachynotus*

goreënsis is a deeper fish than ours is at any age. Its outline and coloration are also different.

Trachynotus maxillosus Cuvier & Valenciennes, also from Africa, comes much nearer our fish, but this differs too much to be safely identified with it.

On the other hand, our young specimens correspond exactly to the two descriptions of little Trachynoti taken by Xantus at Cape San Lucas, published by Professor Gill; the larger one ($2\frac{1}{3}$ inches in length) corresponds entirely to the *T. rhodopus*, the smaller one ($1\frac{1}{10}$ inches in length) to *T. nasutus*. There is, however, no other record of the occurrence of our species in the Pacific.

The drawings and notes made by Professor Poey, of the species called by him *T. carolinus*, have been examined by Professor Jordan. They belong to *T. rhodopus*. *T. carolinus* is therefore as yet not known from Cuba.

Trachynotus carolinus.

Gasterosteus carolinus Linnæus, Syst. Nat., ed. 12, 1766, 490 (Carolina).

Doliodon carolinus Girard, Proc. Acad. Nat. Sci. Phila., 1858, 168; Girard, U. S. & Mex. Bd. Surv., 1839, 22, Pl. xi, fig. 4 (St. Joseph's Island, Texas); Gill, Cat. Fish. East Coast N. A., 1861, 37 (name only).

Trachynotus carolinus Gill, Proc. Acad. Nat. Sci. Phila., 1862, 438; Gill, *op. cit.*, 1863, 84 (Cape San Lucas); Gill, Proc. Acad. Nat. Sci. Phila., 1863, 332 (name only); Gill, Rep. U. S. Fish Com., 1871–2, 803 (name only); Baird, Rep. U. S. Fish Com., 1871–2, 825 (Wood's Holl); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 377 (Beaufort, N. C., no description); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 129 (Pensacola, Fla.); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 112 (name only); Bean, Proc. U. S. Nat. Mus., 1880, 90 (Wood's Holl, New York and Newport, R. I.); Goode, Bull. U. S. Fish Com., 1881, 36; Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 596 (Charleston, S. C., no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 359 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 270 (Pensacola, Fla., no description); Goode, Bull. 21, U. S. Nat. Mus., 1880, 24 (name only); Jordan & Gilbert, Syn. Fish. N. A., 1882, 442; Jordan, Proc. Acad. Nat. Sci. Phila., 1884, 45 (Egmont Key).

Trachinotus cupreus Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 414 (Martinique).

Trachinotus argenteus Cuvier & Valenciennes, Hist. Nat. Poiss., 1831, 413 (Martinique); Storer, Syn. Fishes N. A., 1846, 98.

Trachynotus argenteus Gill, Cat. Fish. East Coast N. A., 1861, 37 (name only).

Trachynotus pampanus Cuv. & Val., *op. cit.* (Charleston, S. C.); Storer, Syn. Fish. N. A., 1846, 99.

Trachynotus pampanus Günther, Cat. Fish. Brit. Mus., ii, 1860, 484 (Jamaica); Gill, Proc. Acad. Nat. Sci. Phila., 1862, 262 (Cape San Lucas).

Bothrolæmus pampanus Holbrook, Ich. S. Cav., 1860 (Charleston); Gill, Cat. Fish. East Coast N. A., 1861, 37 (name only).

Lichia carolina DeKay, N. Y. Fauna, iv, 1842, 114, Pl. x, f. 3 (Sandy Hook); Storer, Syn. Fish. N. A., 1846, 96; Baird, Ninth Rep. Smith. Inst., 1854, 21 (Beesley's Point, N. J.).

Habitat.—Atlantic (and Pacific) Coasts of America: Wood's Holl, Newport, Sandy Hook, Beesley's Point, Beaufort, Charleston, Pensacola, St. Joseph's Island, Egmont Key, Key West, Martinique and Cape San Lucas.

Head 4 in length; depth 2⅜; D. VI–I, 25; A. II–I, 22. Length (No. 434, I. U., Key West) 15½ inches.

Body oblong, comparatively robust; greatest thickness 3 in greatest depth. Snout from mouth to horizontal from upper edge of eye nearly vertical, somewhat bluntly rounded; profile from upper edge of snout to procumbent spine evenly convex. Mouth nearly horizontal, maxillary reaching to vertical from middle of eye, its length 2¾ in head; eye 4½ in head, about as long as snout. Jaws without teeth in adult. Ventrals reach ⅜ distance to vent, about 2 in pectorals, 2½ in head. Dorsal and anal fins falcate; anterior rays nearly reach middle of fins when depressed; dorsal lobe 4½; anal 5½ in length of body. Color bluish above, silvery or slightly golden below; pectorals and anal light orange shaded with bluish; caudal and upper portion of caudal peduncle with bluish reflections.

On our South Atlantic and Gulf Coasts this is by far the most abundant species of the genus, and it is the one most esteemed as food. Its distribution in the West Indies is little known, the only positive record from points south of Key West being that of "*Trachynotus cupreus*" from Martinique. The only specimens known from the West Coast are those taken by Xantus at Cape San Lucas. While we have no good reason to doubt that the specimens now in the National Museum really came from Xantus, it is strange that no later collectors in Lower California and Sinaloa have found either this species or *Trachynotus rhodopus.*

Trachynotus cayennensis.

Trachinotus cayennensis Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 417 (Cayenne); Günther, Cat. Fish. Brit. Mus., ii, 1860, 485 (copied).

? *Trachinotus paitensis* Cuv. & Val., *op. cit.*, viii, 1831, 438 (Peru).

Nothing is known of this species except what is contained in the two meagre descriptions noticed above. No difference is indicated by which the Pacific Coast fish (*paitensis*) is to be known from the Atlantic one. Both appear to differ from *T. carolinus* in the still longer vertical fins.

Trachynotus marginatus.

Trachinotus marginatus Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 411 (Montevideo).

This species appears to be allied to *Trachynotus rhodopus* and *T. goreënsis*, but the description is too brief to give much idea of its relations.

Recapitulation.

We have in this paper admitted eight species of *Trachynotus*, as found in American waters. Some doubt is attached to the nomenclature of some of them. We give in the following list a brief indication of the questions remaining to be solved in each case:—

Genus **TRACHYNOTUS** Lacépède.

1. **T. glaucus** Bloch.
2. **T. fasciatus** Gill.
3. **T. kennedyi** Steindachner (possibly to be considered as a geographical variety of *T. rhomboides* or of *T. ovatus*).
4. **T. rhomboides** Bloch (possibly identical with the East Indian *T. ovatus* Linnæus; if so, to take the latter name).
5. ? **rhodopus** Gill. Very improbably identical with *T. goreensis* Cuv. & Val.; possibly identical with *T. maxillosus* Cuv. & Val., both of them being African species of prior date. Possibly not really found in the Pacific).
6. **T. carolinus** Linnæus (possibly not occurring in the West Indies or in the Pacific).
7. **T. cayennensis** Cuv. & Val. (imperfectly described; possibly the Pacific form of *T. paitensis* is distinct).
8. **T. marginatus** Cuv. & Val. (imperfectly described and doubtful).

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS SYNODUS.

BY SETH E. MEEK.

I have attempted in this paper to give a review of the American species of *Synodus*, with a detailed description of certain species imperfectly described elsewhere. The paper is based on specimens collected by Professor Jordan at Cedar Keys and Key West, Florida, and Havana, Cuba, belonging to the United States National Museum and the Museum of the Indiana University. All the Atlantic species here recognized, except *Synodus saurus*, are contained in this collection.

I am very much indebted to Professor Jordan for use of his library and for other aids.

Analysis of American Species of Synodus.

a. Snout short, obtuse, $3\frac{1}{2}$ in length of premaxillary; head somewhat compressed, much deeper than broad; anal fin comparatively long, its rays about 14; head $3\frac{3}{5}$ in length; origin of dorsal midway between snout and adipose fin; scales 4–55–6 (*Trachinocephalus* Gill). *myops.* 1.

aa. Snout long, pointed, about $2\frac{1}{2}$ in premaxillary; head depressed, little if any deeper than broad; anal comparatively short, rays 10 to 12; head 4 to $4\frac{2}{3}$ in length (*Synodus*).

b. Scales large, 43 to 50 in lateral line; origin of dorsal midway between tip of snout and adipose fin; lateral line with a blunt keel posteriorly.

c. First and last rays of dorsal coterminous when the fin is depressed; black blotch of scapula very small or obsolete; D. I–10; A. I–11 to 12; scales 4–45–5. *intermedius.* 2.

cc. Tips of first dorsal rays not reaching last when the fin is depressed; scapula with a large black blotch; D. I–11 to 12; A. I–10 to 11; scales 4–48–6. *anolis.* 3.

bb. Scales small, 55 to 70 in lateral line.

d. Dorsal fin much higher than long; tips of first rays extending beyond tips of last when the fin is depressed; length of fin $1\frac{3}{6}$ in length of longest ray, and $2\frac{1}{2}$ in head; teeth large; D. I–9; A. I–11; scales 4–57–6. *spixianus.* 4.

dd. Dorsal fin slightly higher than long; tips of first rays not extending beyond tips of last when the fin is depressed; teeth small.

e. Snout broader than long, the jaws subequal; tail with a slight keel; scales $3\frac{1}{2}$–60–6. *saurus.* 5.

ee. Snout longer than broad, the lower jaw included; tail without keel.

f. Four rows of scales between lateral line and adipose fin (6 in an oblique row); origin of dorsal fin nearer adipose fin than tip of snout; scales on cheeks in about 4 to 7 rows, on opercles in 4 to 5 rows.

g. Head very small, $4\frac{3}{5}$ in length; first rays of dorsal coterminous with last ray when the fin is depressed; cheeks with about 4 rows of large scales, opercles with about 4; ventrals $1\frac{1}{7}$ in head; pectoral 2 in head; D. I–10; A. I–12; scales 6–61–6. *scituliceps.* 6.

gg. Head 4 in length; tips of first rays of dorsal not reaching tips of last when the fin is depressed; scales on cheeks in about 7 rows, on opercles in about 5 rows; ventrals $2\frac{1}{3}$ in head; D. I–10 to 11; A. I–10 to 11; scales 4–64–6. *fœtens.* 7.

ff. Six rows of scales between adipose fin and lateral line; cheeks with about 9 rows of scales, opercles with about 8 rows; D. I–10; A. I–11; scales 13–66–16. *lucioceps.* 8.

Synodus myops.

Salmo myops Bloch & Schneider, Systema Ichthyol., 1801, 421 (St. Helena).

Saurus myops Cuvier & Valenciennes, Hist. Nat. Poiss., xxii, 1849, 485 (South Carolina, Martinique, Bahia, St. Helena); Günther, Cat. Fish. Brit. Mus., v, 1864, 398 (Cuba, Jamaica); Jordan & Gilbert, Syn. Fish. N. A., 1882, 281.

Trachinocephalus myops Poey, Syn. Pisc. Cub., 1868, 415 (Cuba).

Salmo fœtens Bloch., Ichthyologia, about 1790, taf. 384, fig. 2; Bloch & Schneider, Systema Ichthyol., 1801, 404 (not Linnæus).

Osmerus lemniscatus Lacépède, Hist. Nat. Poiss., v, 1803, 236 (on a drawing by Plumier).

Saurus truncatus Agassiz, Spix, Pisc. Bras., 1829, 82, tab. 45 (Brazil).

Saurus brevirostris Poey, Memorias Cuba, ii, 1860, 305 (Cuba).

Trachinocephalus brevirostris Poey, Syn. Pisc. Cub., 1868, 415 (Cuba); "anal rays 10;" Poey, Enum., 1875, 144.

Habitat.—Tropical Atlantic; Cuba; Jamaica; Martinique; Bahia; St. Helena; Brazil and South Carolina.

Head $3\frac{2}{3}$ in length of body; depth $5\frac{1}{2}$; D. I–10; A. I–14; scales 4–55–6 (transverse series counted vertically from dorsal fin to vent respectively).

Body little compressed; snout short, obtuse, $3\frac{1}{2}$ in premaxillary; mouth large, premaxillary $1\frac{2}{3}$ in head; interorbital area concave, about $6\frac{1}{2}$ in head, upper surface of head rugose. Dorsal slightly higher than long, its length $1\frac{1}{2}$ in head; origin of dorsal fin midway between tip of snout and adipose fin, slightly behind last rays of ventrals. Anal fin long, its base nearly equal to head; pectorals reaching root of ventrals, 2 in head; tips of ventrals almost reaching vent, ventrals $4\frac{1}{3}$ in length of body; caudal forked; teeth comparatively small; lower jaw slightly projecting. Color grayish, mottled with darker above; body with eleven cross-bars; a black blotch on scapula; a black streak extending from eyes around symphysis, forming a quadrated blotch on the side of each jaw, and one on the median line of each jaw; dorsal fin faintly barred; pectorals, ventrals and anal plain.

This description is taken from a very young specimen, twenty-three inches in length, collected by Professor Jordan in Havana. In the above synonymy we have omitted references from the Pacific Ocean, thinking it not impossible that the Asiatic species (*limbatus*) is a species distinct from *S. myops*. *Trachinocephalus brevirostris* Poey, known only from a drawing made in 1857, seems to differ only in the presence of ten instead of fifteen anal rays. This is probably an error, or perhaps an accidental mutilation. I have little doubt that it is a synonym of *S. myops*.

Synodus intermedius.

? ? ? *Synodus* Gronov., Mus. Ichth., ii, 1765, No. 151, tab. 7, fig. 1.

? ? ? *Esox synodus* Linnæus, Syst. Nat., i, 1766, 516 (America).

? ? ? *Synodus synodus* Bloch & Schneider, Systema Ichthyol., 1801, 396.

? *Saurus synodus* Cuv. & Val., Hist. Nat. Poiss., xxii, 1849 (Martinique; Guadeloupe; Bahia; St. Helena).

? ? ? *Synodus fasciatus* Lacépède, v, 1804, 321.

Saurus intermedius Agassiz, "Spix, Pisc. Brazil, 1829, 81, tab. 44 (Brazil)."

Synodus intermedius Poey, Enum. Pisc. Cub., 1875, 143 (Cuba, not of Synopsis).

Habitat.—Cuba; Brazil.

Head 4 in length of body; depth 6¾; D. I–10; A. I-10; scales 4–44–4 (transverse series counted from dorsal and vent respectively). Body terete, rather robust; snout comparatively long and pointed, about 3¾ in head; mouth large; premaxillary about 1¾ in head; interorbital area concave, about 6½ in head; supraorbital ridge present, terminating anteriorly before the nostrils. Origin of dorsal fin midway between tip of snout and adipose fin; anterior rays of dorsal coterminous with posterior ones when the fin is deflexed; fin higher than long, its length about 2 in head, lower jaw slightly projecting; teeth moderate, anterior palatine teeth largest, becoming smaller posteriorly.

Lateral line with a blunt keel posteriorly, tips of ventrals reaching ⅝ distance to vent, their length about 1¼ in head; tips of pectorals extending to roots of ventrals, 1⅜ in head; caudal forked, lobes equal, scales large. Color yellowish above, lighter below, scales above lateral line punctulate with dark; breast flesh-colored; sides with a row of irregular black markings; scapula occasionally with a small black spot, faintly barred with black; caudal not barred, dusky; tips of middle rays darkest; other fins plain.

This description is taken from several specimens, the largest 5 inches in length, collected by Professor Jordan at Havana.

This is evidently the *Synodus intermedius* of Poey's Enumeratio. I have been unable to examine the figure of Agassiz and Spix, but from the account given of it by Poey, we infer that it is taken from specimens of the present species rather than of *S. cubanus*. According to Poey, the species figured by Spix lacks the scapular spot.

Synodus anolis.

[1] *Saurus anolis* Cuvier & Valenciennes, Hist. Nat. Poiss., xxii. 1849, 438 (Bahia; Martinique).

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[1] Since the above was in type the following notes have been received by Prof. Jordan from Dr. H. E. Sauvage, of the Museum of Paris: "*Saurus anolis* C. & V. Bahia. Type. Length of body 245 m. Lateral line with 54 scales; 10 in a transverse series. A well-marked black spot on the scapular part of the gill-openings." There seems to be no doubt of the identity of *anolis* and *cubanus*.

Saurus intermedius Günther, Cat. Fish. Brit. Mus., v, 1864, 396 (Jamaica; Demarara; Bahia; not of Agassiz).

Synodus intermedius Poey, Syn. Pisc. Cub., 1868, 414 (Cuba); Jordan & Gilbert, Syn. Fish. N. A., 1882, 889; Goode & Bean, Proc. U. S. Nat. Mus., 1882, 239 (name only); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 249 (Pensacola, Fla.).

Synodus cubanus Poey, Enum. Pisc. Cub., 1875, 143 (Cuba).

Habitat.—Atlantic shores of Tropical America; Pensacola; Key West; Cuba; Jamaica; Martinique; Demarara and Bahia.

The description of *Saurus anolis* is so insufficient, that no certain identification can be made.

This species has been sufficiently described by Jordan & Gilbert (Proc. U. S. Nat. Mus., 1882, 249). The large specimens from Key West, examined by me, agree well with this account.

Synodus spixianus.

Saurus spixianus Poey, Memorias Cuba, ii, 1860, 304 (Cuba).

Synodus spixianus Poey, Syn. Pisc. Cuba, 1868, 413 (Cuba); Poey, Enum. Pisc. Cub., 1875, 397 (Cuba).

Habitat.—Cuba; Key West.

Head $4\frac{1}{6}$ in length of body; D. I–9; A. I–11; scales 4–57–6 (transverse series counted from dorsal and vent respectively).

Body oblong, nearly terete; snout comparatively long and pointed, $3\frac{1}{2}$ in head and about $2\frac{1}{2}$ in premaxillary. Interorbital area concave, 6 in head. Eye 5 in head. Supraorbital striate. Branchiostegals 16. Origin of dorsal fin nearer adipose fin than tip of snout by length of dorsal fin; tips of anterior rays reaching beyond tips of posterior ones when the fin is deflexed; the fin is therefore much higher than long. Length of fin $1\frac{3}{8}$ in length of longest ray and $2\frac{1}{2}$ in head. Ventrals moderate, reaching about $\frac{3}{8}$ distance to vent, $1\frac{1}{3}$ in head. Tips of pectorals not reaching to roots of ventrals, about 2 in head. Adipose fin situated over middle of anal. Caudal forked, its lobes equal. Teeth larger than in the other species. Palatine teeth becoming smaller posteriorly. Color light sandy gray, much mottled above with darker olive. Branchiostegals very pale, yellowish. Ventrals and anal pale and plain, lower lobe of caudal dusky, neither barred. Dorsal faintly barred with darker olive.

This description taken from one specimen $8\frac{1}{2}$ inches long, collected by Professor Jordan in Havana. Numerous smaller ones from Key West have also been examined.

Synodus saurus.

Osmerus radiis pinnæ ani undecim Artedi, Descript. Spec. Pisc., 1738, 22 (Mediterranean).

Salmo saurus Linnæus, Syst. Nat., i, ed. 12, 1766, 511 (Europe).

Saurus lacerta Cuvier & Valenciennes, Hist. Nat. Poiss., xxii, 1849, 463 (Europe, not of Risso).

Synodus lacerta Goode, Bull. U. S. Nat. Mus., 1876, 68 (Bermudas).

Saurus griseus Lowe, Trans. Zool. Soc., ii, 1841, 188 (Madeira); Günther, Cat. Fish. Brit. Mus., v, 1864, 394 (Madeira, St. Vincent, Naples, Mediterranean).

I have not seen this species. Professor Goode (Bull. U. S. Nat. Mus., 1876, 68) makes the following reference to its occurrence in the Bermudas:—

"A specimen seventeen inches long was taken off the 'ducking-stool' in March, by a line fisherman. Its occurrence in this part of the Atlantic is very novel, but it agrees closely with a specimen of *Saurus griseus* sent to the United States National Museum by Dr. Günther. Its color was dusky gray above, yellow below. Its formulæ are as follows: Branchiostegals, 16–17 (on opposite sides); D. 12; A. 12; lateral line, 60; transverse line, $\frac{3\frac{1}{2}}{6}$."

Synodus scituliceps.

Synodus scituliceps Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 344 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 354 (Cape San Lucas); Jordan & Gilbert, Bull. U. S. Fish. Com., 1882, 106 (Mazatlan); Jordan & Gilbert, Bull. U. S. Fish. Com., 1882, 109 (Panama).

Saurus fœtens Günther, Cat. Fish. Brit. Mus., 1864, 396 (in part; specimen from Panama).

Habitat.—Mazatlan, Panama.

Synodus fœtens.

Salmo fœtens Linnæus, Syst. Nat., i, ed. 12, 1766, 513 (Carolina).

Saurus fœtens Cuvier & Valenciennes, Hist. Nat. Poiss., xxii, 1849, 471 (Martinique, St. Domingo, Charleston, S. C.; Bahia, Rio Janeiro); Holbrook, Ichth. S. C., 1860, 187.

Synodus fœtens Gill, Rept. U. S. Fish. Com., 1871–2, 810 (name only); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 384 (Beaufort, N. C., no description); Goode, Proc. U. S. Nat. Mus., 1879, 119 (name only); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 342 (Key West); Bean, Proc. U. S. Nat. Mus., 1880, 105 (Beaufort, N. C.; no description); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 239 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 585 (Charleston, S. C.); Jordan & Gilbert, Syn. Fish. N. A., 1882, 280.

? *Coregonus ruber* Lacépède, v, 1804, 263 (on a drawing by Plumier).
? *Saurus longirostris* Agassiz, "Spix, Pisc. Bras., tab. 43, 1829" (Brazil).

Habitat.—Atlantic shores of America: Beaufort, Charleston, Cedar Keys, Key West, Martinique, St. Domingo, Rio Janeiro.

This is the most common species of the genus on the United States Coast. It is well described by Jordan & Gilbert, Syn. Fish N. A., 1882, 280.

Synodus lucioceps

Saurus lucioceps Ayres, Proc. Cal. Acad. Nat. Sci., 1855, 66 (San Francisco); Günther, Cat. Fish. Brit. Mus., v, 1864, 397 (copied).
Synodus lucioceps Jordan & Gilbert., Proc. U. S. Nat. Mus., 1880, 457 (San Francisco, Monterey Bay, Santa Barbara); Jordan & Jouy, Proc. U. S. Nat. Mus., 1881, 13 (San Francisco, Monterey, Santa Barbara); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 42; Jordan & Gilbert, Syn. Fishes N. A., 1882, 281.
Saurus fœtens Lockington, Ann. Mag. Nat. Hist., about 1878 (erroneously identified with the Atlantic species).

Habitat.—West Coast of U. S.: San Francisco, Monterey, Santa Barbara.

This species resembles *Synodus fœtens*, but has much smaller scales. This is shown especially when the number in vertical series is counted. The only accurate description is that of Jordan & Gilbert, Syn. Fish. N. A., 1882, 281.

May 6.

The President, Dr. Leidy, in the chair.

Sixteen persons present.

A Rare Human Tapeworm.—Dr. Leidy directed attention to some little tapeworms, which had recently been submitted to his examination by Prof. William Pepper. They were expelled, by the use of santonin, from a child of three years. The specimens, consisting of a dozen fragments, appear to be portions of three worms, which reached a length of from twelve to fifteen inches, or more. Unfortunately the head is lost. The joints or proglottides are more than several times the breadth of the length. In a specimen of thirteen inches, comprising nearly a complete worm, the joints of the anterior attenuated extremity are about the one-fifth of a millimetre long by nearly two-thirds of a millimetre wide, while the posterior joints are half a millimetre long and two and a quarter millimetres wide. Ripe joints at the posterior part of the body are pale brown, the color being due to the eggs. These occupy a simple uterus defined by the walls of the joints, and not divided into pouches diverging laterally from a main stem as is usual in most tæniæ. A singular feature of the worm is the interruption of the series of ripe joints, here and there, by one or more completely sterile ones. The generative apertures open in the usual way on the lateral margin of one side. The mature eggs are spherical, measure 0·072 mm. diameter, and contain, fully developed, six hooked embryos.

While differing greatly from the ordinary tapeworms infesting man, they approximate nearly the description of *Tæniæ flavopunctata*, and probably pertain to this species. This has been but once previously observed, and was described in 1858 by Dr. Weinland (An Essay on Tapeworms of Man), from specimens in the Museum of the Medical Improvement Society of Boston. These were also discharged by a child. The worm was estimated to be from eight to twelve inches. The joints were marked by a yellow spot, from which the species was named. The eggs measure from 0·054 to 0·06 mm.

Our specimens indicate a worm almost the same size as the *T. flavopunctata*, but the joints are shorter and wider, and exhibit no yellow spot, and the eggs are larger. In other characters the worms sufficiently accord to render it probable that they may pertain to the same species. It is probable that the worm is more common than would be supposed from the instances of its observation, and has perhaps escaped notice from its small size, and from the general ignorance of the distinction, not only of this, but of the ordinary species of tapeworms.

A more complete account of the subject of this communication will shortly appear in the American Journal of Medical Sciences.

MAY 13.

The President, Dr. LEIDY, in the chair.

Fifteen persons present.

How Lycosa fabricates her Round Cocoon.—Dr. H. C. McCook said that while walking in the suburbs of Philadelphia lately, he found under a stone a female Lycosa (probably *L. riparia* Hentz), which he placed in a jar partly filled with dry earth. For two days the spider remained on the surface of the soil, nearly inactive. The earth was then moistened, whereupon (May 2) she immediately began to dig, continuing until she had made a cavity about one inch in depth and height. The top was then carefully covered over with a tolerably closely woven sheet of white spinning work, so that the spider was entirely shut in. This cavity was made against the glass side of the jar, and the movements of the inmate were thus exposed to view. Shortly after the cave was covered, the spider was seen working upon a circular cushion of beautiful white silk, about three-fourths of an inch in diameter, which was spun upwards in a nearly perpendicular position against the earthen wall of the cave. The cushion looked so much like the cocoon of the common tube-weaver, *Agalena nœvia*, and the whole operations of the Lycosa were so like those of that species when cocooning, that the speaker was momentarily possessed with the thought that he had mistaken the creature's identity altogether, and again examined her carefully, only to be assured that she was indeed a Lycosa. After an absence of half an hour, Dr. McCook returned to find that in the interval the spider had oviposited against the central part of the silken cushion and was then engaged in enclosing the hemispherical egg-mass with a silken envelope. The mode of spinning was as follows: the feet clasped the circumference of the cushion, and the body of the animal was slowly revolved; the abdomen—now greatly reduced in size by the extrusion of the eggs—was lifted up, thus drawing out short loops of silk from the expanded spinnerets, which, when the abdomen was dropped again, contracted and left a flossy curl of silk at the point of attachment. The abdomen was also swayed back and forwards, the filaments from the spinnerets following the motion as the spider turned, and thus an even thickness of silk was laid upon the eggs. The same behavior marked the spinning of the silken button or cushion, in the middle of which the eggs had been deposited.

At this stage, Dr. McCook left for an evening engagement, with his ideas as to the cocooning habits of *Lycosa* very much confused, indeed, by an observation so opposed to the universal

experience. Returning to his desk in an hour and a half, he was once more assured by the sight of a round silken ball dangling from the apex of the spider's abdomen, held fast by short threads to the spinnerets. The cushion, however, had disappeared.

The mystery (as it had seemed to him) was solved: the Lycosa after having placed her eggs in the centre of the silken cushion, and covered them over, had gathered up the edges and so united them and rolled them as to make the normal globular cocoon of her genus, which she at once tucked under her abdomen in the usual way. This was a most interesting observation, and Dr. McCook thought had not before been made; at least Lycosa's manner of fabricating a cocoon had been heretofore unknown to him; and by reason of her subterranean habit the opportunity to observe it was rare. He had often wondered how the round egg-ball was put together, and the mechanical ingenuity and simplicity of the method were now apparent. The period consumed in the whole act of cocooning was less than four hours; the act of ovipositing took less than half an hour. Shortly after the egg-sac was finished, the mother cut her way out of the silken cover. She had evidently thus secluded herself for the purpose of spinning her cocoon. While feeding the spider some flies, the cave was accidentally filled up, and no effort had been made to dig another, although it is the custom of this genus, in natural environment, to remain pretty closely within such a habitation while carrying the cocoon.

One month after the above date (June 4), the spider was found with the young hatched, and massed upon her body from the caput to the apex of the abdomen. The empty egg-sac still clung to the spinnerets, and the younglings were grouped over the upper part of the same. The abdomens of the little spiders were of a light yellow color, the legs a greenish brown or slate-color, and the whole brood were tightly compacted upon and around each other, the lower layers apparently holding on to the mother's body, and the upper upon those beneath. Twenty-four hours thereafter, the cocoon-case was dropped, and the spiderlings clung to the mother alone. An examination of the cocoon showed that the young had escaped through the thin seam or joint formed by the union of the egg-cover with the circular cushion, when the latter was pulled up at the circumference into globular shape. There was no flossy wadding within—as is common with orb-weaving spiders, for example—nothing but the pinkish shells of the escaped young. On June 11, about one hundred of the spiderlings had abandoned the maternal perch, and were dispersed over the inner surface of the jar, and upon a series of lines stretching from side to side. About half as many more remained upon the mother's back; but by the 13th, all had dismounted. Meantime, they had increased in size at least one-half, apparently without food.

Note on the Amphibious Habit of Lycosa.— Dr. McCook alluded to another interesting fact in the life-history of *Lycosa*, brought to his attention by Mr. Alan Gentry. This gentleman, during the winter, visited a pond in the vicinity of Philadelphia (Germantown) which was frozen over. He cut a slab from the ice about eight to ten feet from the bank, and was surprised to see several spiders running about in the water. They were passing from point to point by silken lines stretched underneath the surface between certain water-plants. Several were captured, but unfortunately the specimens were not preserved. Mr. Thomas G. Gentry, who saw them, says that they were Lycosids, and from his description of the eyes he is evidently correct. It is a remarkable and novel fact to find these creatures thus living in full health and activity in mid-winter *within* the waters of a frozen pond, and so far from the bank in which the burrows of their congeners are so commonly found. It has been believed, heretofore, and doubtless it is generally true, that the Lycosids winter in deep burrows in the ground, sealed up tightly to maintain a higher temperature. But the above observation opens up a new and very strange chapter in the winter behavior of these spiders, as well as in the amphibious nature of their habits.

Pentastomum proboscideum.—Prof. Leidy exhibited specimens of this parasite, presented to him by Mr. Norman Spang, of Etna, Pa., who recently obtained them in Florida, from the lung of a large rattlesnake, *Crotalus adamanteus*.. They are cylindrical incurved, annulated, largest and rounded at the head, tapering behind, and becoming again larger and rounded at the end; and terminating ventrally in a short conical point. There are six of them, with the following measurements:—9 lines long by $1\frac{1}{2}$ lines at the head; 13 lines by $1\frac{1}{2}$ lines; 24 by $2\frac{1}{2}$; 28 by $2\frac{1}{2}$; 30 by 3, and 31 by 3. The species was first found by Humboldt in *Crotalus horridus*. It is common in the *Boa constrictor*, in which Professor Leidy had also observed it several times. It has likewise been found in a number of other serpents. Other species occur in different mammals, including man, reptiles and fishes. These singular parasites are regarded as the most degraded form of arachnida, in the mature stage being reduced to a worm-like, limbless body.

May 20.

Mr. Thomas Meehan, Vice-President, in the chair.

Eighteen persons present.

The Nature of a Fasciated Branch.—At the meeting of the Botanical Section on the 12th, Mr. Thomas Meehan called attention to a paper contributed by him to the *Proceedings of the*

American Association for the Advancement of Science, p. 277, vol. xix, 1870, in which, contrary to the accepted hypothesis that a fasciated branch was due to "over-luxuriance," or a high condition of vitality, he showed that the result was due to a degradation of vital power. A number of phenomena conceded to result from low vital conditions, were shown to be inseparably connected with fasciation, the essential feature of which is the production of an extraordinary number of buds, with a corresponding suppression of the normal internodal spaces.

This is precisely the condition of a flowering branch; and all its attendant phenomena find their analogue in a fasciated stem. Taking a composite flower in illustration—a sunflower, for instance—we find on the receptacle a coil of many hundred florets, each floret with a chaffy scale at the base. Each of these florets in morphology represents a branch, and the scale a leaf or bract, from the axil of which the branch would have sprung. If we imagine the head uncoiled, and everything in a normal vegetative condition, as distinct from the condition of inflorescence, we might have a sunflower plant a hundred feet high or more. But with the approach to the flowering stage we have a suppression of vegetative development, with a highly accelerated development of buds, out of which are morphologized the floral parts.

The receptacle on which the involucral scales and other parts of inflorescence in a compound flower, had also its analogue in the thickened stems which bore the buds in a fasciated branch.

The phenomena which indicated low vital power in the fasciated branch, were all manifested in a flower. Taking the test of vital power as the ability to retain life under equal circumstances, we find the leaves on a fasciated branch dying before those on the rest of the tree. On the balsam fir, an evergreen, the leaves are wholly deciduous; or a deciduous ally, the larch, the leaves mature before the others. On other trees we find always the leaves enduring longer than those on the fasciated. We say the leaves on the latter have a lower vital power. In severe winters the branches in the fasciation wholly die, in many cases, while those on other portions of the tree survive, and again we say, because they have a lower vital power. Precisely the same circumstances attend inflorescence. The leaves in their procession from a normal condition to petals lose this evidence of vitality in proportion to the degree of transformation. The petal dies before the sepal, the sepal before the bract, and the bract before the leaves, in the general order of anthesia, in a compound flower, though there are cases where, secondary causes coming into play, this rule would be reversed, but, in a general way, the soundness of the point would not be disputed.

From all these facts in analogy it might be said in addition to the points brought out in the paper of 1870, above cited, that *a fasciated branch is an imperfect and precocious attempt to enter on the flowering or reproductive stage.*

On Rapid Changes in the History of Species.—Mr. THOMAS MEEHAN exhibited flowers of the remarkable *Halesia* noted at page 82, and remarked on the wide divergence reached without any intervening modifications from the original, and observed that it was another illustration of what he thought must now be generally accepted, that the maxim of Ray "*Natura non facit saltum*" itself needed modification. He had called attention to this particular departure, among others, in a paper before the *American Association for the Advancement of Science*, in 1874;[1] what he desired to do now was to emphasize a few of the points brought out prominently in that paper, that "Variations in species, as in morphological changes in individuals, are by no means by gradual modifications; that suddenly formed and marked variations perpetuate themselves from seeds, and behave in all respects as acknowledged species; and that variations of similar characters would appear at times in widely separated localities."

In addition to the illustrations given in that paper, a remarkable one was afforded by the *Richardia æthiopica*, the common "calla" of gardens, the present season. Some four inches below the perfect flower a mere spathe was developed, partially green, but mostly white, as usual, but in this case we do not call it a spathe, but a huge bract. In other words, the usually naked flower-scape of the *Richardia* had borne a bract. Flowers with a pair of more or less imperfect spathes were not uncommon in some seasons; the peculiarity of the present season was the interval of several inches on the stem, which justified the term of bract to the lower spathe. From the vicinity of Philadelphia numbers had been brought to him, and others had been sent from Ohio, Indiana and Illinois—some hundreds of miles apart. What was the peculiarity in this season over others which induced the production of this bract, was one question. Whatever it may have been, it operated in bringing about a change of character, without the intervention of seed, directly on the plant, and in many widely separated places at the same time. What is to prevent a law which operates exceptionally in one season, operating again and in a regular and continuous way? So far as we can understand there can be no reason; and, if it should, we have a new species, not springing from a seed, or one individual plant—constituting one geographical centre of creation from which all subsequent descendants emigrated and spread themselves—but a whole brood of new individuals already widely distributed over the earth's surface, and entirely freed from the "struggle for existence" which the development of a species from a solitary individual presupposes.

Aside from the great value of this illustration of how the whole character of a species might be modified simultaneously

[1] See Proc. Amer. Assoc. Ad. Science, vol. xxiii, p. B. 9.

over a wide extent of country, it afforded a lesson in environment. External circumstances may influence modification, but only in a line already prepared for modification. This must necessarily be so, or change would be but blind accident, whereas palæontology teaches us that change has always been in regular lines, and in co-ordinate directions which no accident has been able to permanently turn aside. Just as in the birth of animals, we find, that however powerful may be some external law of nutrition, which, acting on the primary cell of the individual decides the sex, yet we see that no accident has been able to disturb the proportion of the sexes born, which has always been, so far as we know, nearly equal. So in the birth of species, making all allowance for the operation of environment, the primary plan has been in no serious way disturbed; we have to grant something to environment in the production of new forms, but only as it may aid an innate power of change, ready to expend itself on action as soon as the circumstances favor such development—circumstances which after all have very little ability to determine what direction such change shall take.

We know that distinct forms do spring through single individuals from seed, and that, after battling successfully with all the vicissitudes of its surroundings, a new form may succeed in spreading, through the lapse of years or ages, over a considerable district of country. But the idea that always and in all cases species have originated in this manner, presents, occasionally, difficulties which seem insurmountable. In the case of the similarity between the flora of Japan and that of the eastern portion of the United States, we have to assume the existence of a much closer connection between the land over what is now the Pacific Ocean, in comparatively modern times, in order to get a satisfactory idea of the departure of the species from one central spot; and to demand a great number of years for some plants to travel from one central birthplace before the land subsided, carrying back species in geological time further, perhaps, than mere geological facts would be willing to allow. But if we can see our way to a belief that plants may change in a wide district of country simultaneously in one direction, and that these changes once introduced, be able to perpetuate themselves till a new birth-time should arrive, we have a great advancement towards simplifying things.

May 27.

Mr. J. H. Redfield in the chair.

Twenty-three persons present.

Mr. Henry N. Rittenhouse was elected a member.

The following were ordered to be printed:—

NEW FOSSILS FROM THE FOUR GROUPS OF THE NIAGARA PERIOD OF WESTERN NEW YORK.

BY EUGENE N. S. RINGUEBERG.

MEDINA GROUP.

Sphirophyton archimedes (n. sp.). Pl. II, fig. 1.

Frond large, thick; growing in loose spirals that gradually decrease in size from below upwards; about two coils occur in the space of the diameter.

Surface on both sides crossed by broad, irregular, gently undulose, wavy plications, which radiate from the centre out towards the obtuse rounded margins in subspiral curves, which traverse about one-fourth of the coil, following the general spiral growth, which is sinistral.

This fucoid is specially remarkable for its thickness and loose spiral growth. It differs from those figured by Hall by growing in decreasing spirals instead of expanding from below up.

From the upper friable bands of the Medina sandstone at Lockport.

CLINTON GROUP.

TRIACRINUS (n. gen.).

Calyx symmetrical, subelongate, ovoid to pyriform.

Basals five, arranged in a bilaterally symmetrical series, the median of which is placed to the right of the anal, and is pentagonal; the two next on either side are low quadrangular, and the outer adjoining two, which are wider than the others, are pentagonal and have their superior apices directed away from each other.

The second ring is tripartite and comprised of the large anal and the lower elongated and expanded portion of the two lateral anterior radials.

Anal very large, forming nearly one-third of the circumference of the calyx; equilaterally heptagonal; it rests on one of the quadrangular radials and laterally against the sloping sides of two adjacent pentangular ones.

The third or true radial ring is equally quinquepartite and has with the second ring—which is really but a modified portion of the third—a bilateral symmetry, but differing from that of the

basals in its axis, which is governed by the anal. Plates five, three small and two large, of subequal sizes; upper portion incurved so as to form part of the brim of the dome; deeply excavated above in the incurved portion, with dove-tailed notches to receive the brachials; first two radials on the posterior side small, resting on the sloping sides of the anal and the posteriorly expanded portion of the next radials; lateral radials much elongated, so as to rest upon the basals; and have the elongated portion much expanded, especially anteriorly, where they meet under the anterior radial: anterior radial small, supported by the lateral radials upon their expanded portion, which in the dextral one is supported by three basals like the anal, while the other rests on the two wider pentagonal basals and consequently has an acute inferior angle instead of a truncate one.

This anomalous genus should probably be placed next to *Hybocrinus* with which it has some slight affinity.

So far found only in the Clinton Group.

Triacrinus pyriformis (n. sp.). Pl. III, fig. 1.

Calyx small, subpyriform.

Base broad, truncate, with a slight, flat, wide depression to receive the column which was here evidently about as broad; leaving only a fine sharp projecting marginal ring.

Height to width as three to two.

Basals medium; first to the right of anal; acutely pentagonal, height and width about equal; the quadrangular plates are about one-half as high as the pentagonal ones; height to width as one to two; the two adjoining pentagonal plates are as high as the other, and are wider than high; extending nearly half way around the basal ring.

Second ring equally trichotomous. Anal large, slightly wider than high.

First two posterior radials medium, obversely equiform with their lower and external lateral sides curving outwards; lateral large radials slightly expanded posteriorly and widely anteriorly; anterior radial equilateral, with lateral angles fitting into the expanded radials upon which it rests. The wide dove-tailed incisions to receive the brachials are about two-thirds as wide as the upper part of the plates, at their lower expanded portion; above which point the upper part of the plate is rather abruptly

incurved. Height three-eighths inch. From the limestone of the upper portion of the Clinton Group at Lockport.

Triacrinus globosus (n. sp.) Pl. III, fig. 2.

Calyx small, globosely subovoid; base large, deeply excavated with rounding margins; sides evenly rounding from the base to the lateral apices of the incurved projections of the radials.

Basals incurved to receive the column, low at the sutures; quadrangular basals very low, height to width as one to three; about one-half of their height is incurved into the excavated base.

Anal large, almost as high as wide.

Expanded portion of the lateral radials wide, forming more than two-thirds of the second ring.

Anterior radial evenly rounding from the lateral sides to an acute inferior angle.

Expanded portion of the brachial notches about one-half as wide as the plate at that point.

The specific features of this species in comparison with the other, are the ovoid calyx, much more deeply excavated and rounded base, narrower brachial notches in the radials, and the evenly rounded sides of the small anterior radial. Height same as last species; width nearly equal to the height. The specimen from which the description is taken is slightly distorted by pressure.

Locality and group the same as *T. pyriformis*.

Stictopora obliqua (n. sp.) Pl. II, fig. 2.

Flat, large, broad and long, of equal width; with a central band of upward-curving rounding lines of growth, which are irregular in distance from each other, and as regards strength; they occupy from one-third to one-half of the surface, and are sometimes deflected slightly to one side or the other; the outer ends of these striæ of growth gradually disappear as they curve downwards and approach each other upon the flat, unstriated margins; but occasionally one or two striæ are more prominent than the rest, and extend further downwards and outwards.

Cells arranged in longitudinal and rectangular transverse rows on the unstriated marginal thirds; from which point the transverse rows are deflected downwards, and meet with a rounding curve in the central portion.

The cells of the outer portions are sub-rhombic, with an outward inclination of their outer upper corners; deflected rows of

cells rhomboid, becoming gradually quadrangular towards the centre.

FUNGISPONGIA (n. gen.)

Flattened; spreading from a fixed point; thinning out at the margin.

From the attached portions, numerous perforations, with smooth walls, radiate and branch out with many bifurcations and anastomoses in all directions towards the periphery, having numerous communications with the outer surface, which is quite smooth.

Fungispongia irregularis (n. sp.) Pl. III, fig. 3.

Flat, rather thin, irregularly spreading from a lateral or excentric point of growth. Surface moderately convex; rather abruptly beveled off to a sharp margin, which is somewhat irregular in contour. Internal structure consisting of small, closely arranged radiating perforations, which, though apparently of a quite regular circular form separately, are very irregular in section, in consequence of the frequent bifurcations and intercommunications occurring in their outward course. They do not always open directly upon the rather smooth surface, but are directed outwards towards the margin and frequently end in furrows on the outside.

The specimen from which this description is taken, is somewhat weathered in the central part, so as to well show its structure. From the siliceous bands of the Clinton at Lockport.

NIAGARA TRANSITION GROUP.

Stictopora graminifolia (n. sp.). Pl. III, fig. 4.

Very long and narrow, ribbon-like; width one-eighth inch, even throughout, flat on the noncellular and slightly convex on the cellular side.

The striæ of the lines of growth are abruptly arched in the centre, where they are accompanied by undulations of the surface having the same general curve, but which are confined to the central portion; the striæ grow more crowded as they gradually approach the margin, which they continue to do for a distance about equal to the width of the flat surface, where they become lost just before reaching it by being merged with others in common longitudinal striæ, which extend some distance down the side before they become finally lost.

Central third occupied by five or six longitudinal rows of cells, which continue throughout its entire length; from these the lateral cells are directed in nearly straight lines obliquely outwards and upwards towards the margins, at an acute angle. Cells twice as long or longer than their width and are arranged irregularly in the rows, without any apparent order.

The length of the specimen is two and one-fourth inches, which was not its entire length, several fragments having been lost off either end.

From the compact, fine-grained Niagara Transition Group limestone, which was described by me in the *American Naturalist*, Sept., 1882, at Gasport.

Niagara Group.

Eucalyptocrinus inconspectus (n. sp.). Pl. III, fig. 5.

Calyx large, cup-shaped, wide, upper part with perpendicular sides; base rounding, obconical with a small excavation to receive the column.

Column and arms unknown.

Surface finely rugose; rugæ giving evidence of irregular radiations from the centre of the larger plates.

Basals concealed within the depression to receive the column. First radials medium, rapidly expanding. Second radials large, as high as wide. The rest of the plates, excepting the elongate interradials and interbrachials, wider than high. Radial plates, with the exception of the second, flattened or even slightly depressed, slightly wider than high.

This species may be distinguished from *E. crassus* by the, comparatively, very shallow basal excavation which receives the column; also by the finely rugose surface-markings, the rounding base and nearly parallel sides at the upper part of the calyx. And from *E. decorus* by the longer calyx and surface-markings.

From the Niagara limestone at Lockport.

Cornulites contractus (n. sp.). Pl. III, fig. 6.

Shell much elongated, cylindrical or subcylindrical, very gradually tapering; regularly sharply annulate; longitudinally finely striate.

Growing attached to foreign bodies or in groups when young.

Annulations very sharply defined, equidistant; about five to

one-fourth inch in the larger specimens; they rise by an even curve from the rounded, contracted, inter-annular spaces and form sharp angular annulations.

Longitudinal striations prominent, closely arranged, and are strongest at the bottom of the trough-like depressions, having there the appearance of being minute plications produced by the contraction; they grow fainter at the apex of the annulations, but continue over them to the next. The sloping sides of the annulations sometimes bear one or two inconspicuous annulations which do not interfere with the contour of the shell.

The prominence and regularity of the annulations in the older portions of the shell will serve to distinguish it from *C. proprius*, with which it is associated, and to which it sometimes bears a superficial resemblance in the younger attached part.

From the Niagara shale at Lockport.

Cornulites nodosus (n. sp.). Pl. III, fig. 7.

Shell small, elongate, tapering gradually to an attenuate, very sharp apex.

Growing on small foreign bodies; attached throughout. Surface smooth, ornamented by numerous closely arranged nodes, which increase in size as the shell enlarges, and are placed in regular rows across it; the terminal ones being somewhat elongate and attached to the surface upon which it grows.

The largest specimen found measures five thirty-seconds of an inch in length.

From the Niagara shale at Lockport.

Lingula bicarinata (n. sp.) Pl. III, fig. 8.

Shell small, ovoid in outline; beak very acute; transverse diameter widest half way from the beak; valves evenly rounding, convex; with two hardly perceptible parallel median ridges commencing at the beak and extending to the outer margin, widening regularly as the shell increases in size.

Concentric striæ fine, even, increasing regularly by several bifurcations.

From the Niagara Shale at Lockport.

The specimens described were all collected by myself, and the types are in my collection.

EXPLANATION OF PLATES.

Plate II.

1. *Spirophyton archimedes* (n. sp.)
Two whorls of a large specimen, natural size.

1 *a*. Lower side of a part of a smaller frond, showing more plainly the subspiral undulations.

2. *Stictopora obliqua* (n. sp.)
Natural size.

2 *a*. A small portion of it enlarged, showing the oblique downward curve of the transverse rows; three diameters.

Plate III.

1. *Triacrinus pyriformis* (n. gen. et sp.); natural size.
   a. Posterior side; enlarged three diameters.
   b. Anterior side; enlarged three diameters.
   c. Basal view; enlarged three diameters.
   d. Upper side; enlarged three diameters.
   e. Diagram of plates.

2. *Triacrinus globosus* (n. sp.)
The lettering of the figures same as last.

3. *Fungispongia irregularis* (n. gen. et sp.)
   a. Section; enlarged three diameters.

4. *Stictopora graminifolia* (n. sp.)
   a. Portion; enlarged three diameters.

5. *Eucalyptocrinus inconspectus* (n. sp.)

6. *Cornulites contractus* (n. sp.)
   a. A group of three individuals growing together.
   b. Surface of 6; enlarged three diameters.

7. *Cornulites nodosus* (n. sp.)
   a. Same individual; enlarged three diameters.

8. *Lingula bicarinata* (n. sp.)
Interior of valve.

JUNE 3.

Mr. EDWARD POTTS in the chair.

Fifteen persons present.

A paper, entitled "On the Mutual Relations of the Hemibranchiate Fishes," by Theodore Gill, was presented for publication.

Opposite Leaves in Salix nigra.—At the meeting of the Botanical Section on June 2, Mr. THOMAS MEEHAN remarked that few botanists would expect to find opposite leaves in *Salix;* but in *S. nigra* Marshall, they appear at a certain stage of growth, which has much significance. This species is of that section which has the flower coætaneous with the leaves; that is to say, instead of the aments being sessile they terminate short branches. They are, however, not absolutely terminal, but appear so by the suppression for a time of the terminal bud. In the case of the female ament this terminal bud usually starts to grow very soon after the flowers mature, and forms a second growth, when the fertile catkin or raceme of fruit, becomes lateral. It is the first pair of leaves on this second growth that is opposite—all the rest are alternate as in the normal character of the genus. The leaves are so uniformly opposite under these circumstances, that there must be some general law determining the condition, which has not yet been developed.

JUNE 10.

Mr. GEO. W. TRYON, JR., in the chair.

Fourteen persons present.

A paper, entitled "On the Anacanthine Fishes," by Theodore Gill, was presented for publication.

JUNE 17.

Rev. H. C. McCOOK, D. D., Vice-President, in the chair.

Thirteen persons present.

A Spider that makes a spherical Mud-daub Cocoon.—The Rev. Dr. H. C. McCOOK said that in November, 1883, he received from Mr. F. M. Webster, Assistant State Entomologist of Illinois, two globular nodules of earth, about the size of a grape, which were thought to be the cocoons of a spider. Similar balls had often been found attached, by a slender thread or cord of silk, to the underside of boards laid down on the ground. From some of

ON THE MUTUAL RELATIONS OF THE HEMIBRANCHIATE FISHES.

BY THEODORE GILL.

§ 1. *Introductory.*

In my "Arrangement of the Families of Fishes," (1872, p. 13, 14) before I was aware of the peculiarities of the shoulder girdle, and only knowing the characters assigned to the order by Cope, I retained the Hemibranchii in the order Teleocephali, but in the introductory commentary (p. xxxix) I raised the group to ordinal rank, to which it seems entitled. Prof. Cope, however, is entitled to the credit of having first appreciated the distinctness of the group as a whole, although the characters assigned to it were not, perhaps, of the highest systematic value. As now understood, the order seems to be definable as follows:—

HEMIBRANCHII.

= *Hemibranchii*, Cope, Proc. Am. Ass. Adv. Science, v. 20, p. 338, 1872.
= *Hemibranchii*, Gill, Arrangement Families Fishes, p. xxxix, 1872 (Based on shoulder girdle).
= *Hemibranchii*, Cope, Proc. Am. Phil. Soc., v. 13, p. 25, 1873.
= *Hemibranchii*, Gill, Johnson's New Universal Cyclopædia, v. 2, p. 872, 1877 (defined).
= *Hemibranchii*, Jordan & Gilbert, Syn. Fishes N. Am., p. 387, 1882.
Acanthopterygii, fam., *auct. plur.*

In the "Arrangement of the Families of Fishes" (1872, pp. 13, 14), six families were recognized for the Hemibranchs, whose combinations and correspondence with the families of previous authors are shown in the following abstract:—

"(H. Gasterosteiformes.)

(Gasterosteoidea.)

133. *Gasterosteidæ*	*Gasterosteidæ*, Gthr., i, 1–7.
134. *Aulorhynchidæ*	*Aulorhynchoidæ*, Gill, P. A. N. S. Phil., 1862, 233.

(Aulostomoidea.)

135. *Aulostomidæ*	*Fistulariidæ*, Gthr., iii, 529, 535–538.
136. *Fistulariidæ*	*Fistulariidæ*, Gthr., iii, 529–534.

(H. Centrisciformes.)

137. *Centriscidæ*	*Centriscidæ*, Gthr., iii, 518–524.
138. *Amphisilidæ*	*Centriscidæ*, Gthr., iii, 518, 524–527."

In the "Introduction to the Study of Fishes" (1880, p. 507), Dr. Günther has referred the Aulorhynchoid fishes to the family Fistulariidæ.

In the "Synopsis of the Fishes of North America" (1882, p. 387), five families were recognized for American species by Messrs. Jordan & Gilbert, and grouped as follows :—

"* Bones of head produced into a long tube, which bears the short jaws at its end.

a. Body short, compressed, scaly; no teeth; spinous dorsal present. . . . . . *Centriscidæ*, 60.

aa. Body elongate; teeth present.

b. Dorsal spines none; a long caudal filament; no scales. *Fistulariidæ*, 61

bb. Dorsal spines present, disconnected; no caudal filament.

c. Body covered with ctenoid scales. *Aulostomatidæ*, 62.

cc. Body scaleless, with bony shields. *Aulorhynchidæ*, 63.

** Bones of head moderately produced; ventrals I, 1; dorsal preceded by free spines; body scaleless, naked or mailed. *Gasterosteidæ*, 64."

On a recent review of the forms of the order, I am more than ever convinced of the aptness of the classification proposed by myself in 1872 and submit the following table and characters which will, I think, amply justify that confidence. Far from being able to see any close affinity between the Aulorhynchidæ and Aulostomidæ, I am unable to appreciate any very distinctive differences from the Gasterosteidæ, and the close affinity between *Aulorhynchus* and *Spinachia* is such that I regard the family Aulorhynchidæ simply as a convenient one at the most, and as expressing the culmination in one direction of the tendency characteristic of the order. I should be scarcely disinclined to dissent from any who should combine the Gasterosteidæ and Aulorhynchidæ in one family.

§ 2. *Synopsis of Families.*

I. Dermal armature absent or developed only as plates on sides or back; vertebræ numerous (30 to 86); pubic bones connected with scapular arch; spinous dorsal represented by isolated spines.

1. Vertebræ anteriorly little enlarged; ventrals subthoracic, with enlarged spines (*Gasterosteoidea*).

a. Branchiostegal rays three; ventrals with one ray each; snout conic or but slightly tubiform. *Gasterosteidæ.*

b. Branchiostegal rays four; ventrals with four rays each; snout tubiform. . . . . *Aulorhynchidæ.*

2. Vertebræ anteriorly (first four) elongate; ventrals subabdominal or near middle, without spines, but with 6 (or 5) rays (*Aulostomoidea*).

c. Dorsal spines developed, weak; body compressed, moderately long, with ctenoid scales. . . *Aulostomidæ.*

d. Dorsal spines undeveloped; body depressed or subcylindrical, very long, without scales (caudal with the two middle rays produced into a long filament). *Fistulariidæ.*

II. Dermal armature superficial, developed anteriorly and especially about the back; four anterior vertebræ much elongate; tail with its axis continuous with that of the abdomen; branchihyals and pharyngeals mostly present (fourth superior branchihyal and first and fourth superior pharyngeals only wanting); pubic bones not connected with the scapular arch; a spinous dorsal fin developed (*Macrorhamphosoidea*). . . . . . *Macrorhamphosidæ.*

III. Dermal armature connate with the internal skeleton, and developed as (1) a dorsal cuirass in connection with the neuropophyses and (2) lateral shields connected with the ribs; vertebræ reduced; six or more anterior vertebræ extremely elongate, with normal articulations of centra; tail with its axis deflected from that of the abdomen by encroachment of a dorsal cuirass over the dorsal fin; branchial system feebly developed (fourth superior branchihyal and all the superior pharyngeals wanting); pubic bones not connected with the scapular arch; a spinous dorsal feebly developed under the posterior projection of the dorsal buckler. (*Amphisiloidea*) . . *Amphisilidæ.*

§ 3. *Diagnoses of Groups.*

GASTEROSTEIDÆ.

Synonyms as families.

< *Atractosomes*, Duméril, Zool. Anal., 14e fam., p. 124, 1806.
< *Acanti*, Rafinesque, Indice d'Ittiolog. Siciliana, 15. ord., p. 18, 1810.
< *Atractomia* (*Caranxia*), Rafinesque, Analyse de la Nature, 8e fam., p. —, 1815.
< *Scombéroides*, Cuvier, Règne Animal [1. ed.], t. 2, p. 311 (319), 1817.
< *Percoides?* Latreille, Fam. Nat. du Règne Animal, p. 135, 1825.
< *Centronotides*, Risso, Hist. Nat. de l'Europe Merid., t. 3, p. 426, 1826.
< *Zeidæ*, Swainson, Nat. Hist. and Class. Fishes, etc. v. 2, p. 241, 1839.
< *Triglidæ* (*Gasterosteini*), Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 32), 1832.
= *Gasterosteidæ*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 133, 1838; t. 4, p. 275, 1840.
= *Gasterosteidæ*, Girard, Expl. and Surv. for R. R. Route to Pacific Oc., v. 10, Fishes, p. 84, 1858.
= *Gasterosteoidei*, Bleeker, Enum. Sp. Pisc. Archip. Ind., p. xxiii, 1859.
= *Gasterosteidæ*, Günther, Cat. Fishes Brit. Mus., v. 1, p. 1, 1859.
= *Gasterosteoidæ*, Gill, Cat. Fishes E. Coast N. A., p. 39, 1861.
= *Gasterosteidæ*, Cope, Proc. Am. Assoc. Adv. Sci., v. 20, p. 338, 1872.
= *Gasterostei*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 34, 1873.
= *Gasterosteidæ*, Günther, Int. to Study of Fishes, p. 504, 1880.
= *Gasterosteidæ*, Jordan & Gilbert, Syn. Fishes N. Am., pp. 387, 392, 1833.
Percoides [?], Latreille, 1825.
Triglidæ, Subf. *Gasterosteini*, Bonaparte, 1832.

Hemibranchs with the anterior vertebræ little enlarged, a more or less fusiform body, conic or moderately produced snout, sides naked, or with a row of bony shields, and ventrals subthoracic, each with a large spine, and one or two rays.

Apeltinæ.

Gasterosteids with post-thoracic ventrals, pubic bones widely separated behind and extending on the sides, a moderately projecting snout, and a moderate caudal peduncle.

APELTES.

= *Apeltes* (Brevoort), Gill, Cat. Fishes E. Coast N. A., p. 39, 1861; Canad. Nat., n. s., v. 2, p. 8.
= *Apeltes*, Jordan, Man. Vertebrates Northern U. S., p. 249, 1876.
< *Gasterosteus*, Sauvage, Nouv. Arch. Mus. d'Hist. Nat. Paris, t. 10, pp. 7, 29, 1874. (Subgenus).

Apeltines with the branchial apertures restricted and three free dorsal spines.

Type, *A quadracus* = *Gasterosteus quadracus* Mitch.

Gasterosteinæ.

Synonyms as subfamilies.

< *Gasterosteini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 82), 1832; Nuovi Annali delle Sci. Nat., t. 2, p. 183, 1838; t. 4, p. 275, 1840.

< *Gasterosteinæ*, Gill, Cat. Fishes E. Coast N. A., p. 39, 1861; Canad. Nat., n. s., v. 2, p. 8, 1865.

Gasterosteids with post-thoracic ventrals, pubic bones connected and constituting a triangular median plate, a moderately projecting snout, and a moderate caudal peduncle.

EUCALIA, Jordan.

=*Eucalia*, Jordan, Man. Vertebrates Northern U. S., p. 248, 1876.

Gasterosteus sp., Kirtland, Agassiz, *et al.*

Gasterosteines with the branchial apertures confluent, and four or five non-divergent and equally reclinable free dorsal spines.

Type, *E. inconstans* = *Gasterosteus inconstans* Kirtland.

PYGOSTEUS.

< *Leiurus*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 242 (subgenus).

= *Pygosteus* (Brevoort), Gill, Cat. Fishes E. Coast N. A., p. 39, 1861; Canad. Nat., n. s., v. 2, p. 8.

= *Pygosteus*, Jordan, Man. Vertebrates Northern U. S., p. 249, 1876.

= *Gasterostea*, Sauvage, Nouv. Arch. Mus. d'Hist. Nat. Paris, t. 10, pp. 7, 29, 1874. (Subgenus).

Gasterosteus sp., Artedi, Linnæus, Lacépède, Cuvier, Fleming, Cuv. & Val., Girard, Günther, etc.

Gasteracanthus sp., Pallas.

Gasterosteines with the branchial apertures confluent (the branchiostegal membrane having a free inferior margin), and seven to eleven generally divergent spines.

Type, *P. pungitius* = *Gasterosteus pungitius* L.

GASTEROSTEUS.

< *Gasterosteus*, Artedi, Genera Piscium, p. 52, 1738.

< *Gasterosteus*, Linnæus, Syst. Nat., ed. x, t. 1, p, 295, 1758.

< *Gasterosteus*, Lacépède, Hist. des Poissons, t. 3, p. —, 1802.

< *Gasteracanthus*, Pallas, Zoographia Rosso-Asiatica, t. 3, p. 228 (1811), 1831,

< *Gasterosteus*, Cuvier, Règne Animal, 1re éd., t. 2, p. 300, 1817. (Subgenus).
< *Gasterosteus*, Fleming, Hist. Brit. Animals, p. 219, 1828.
< *Gasterosteus*, Cuvier & Valenciennes, Hist. Nat. des Poissons, t. 4, p. 479, 1829.
× *Gasterosteus*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 242, 1839.
× *Leiurus*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 242. (Subgenus).
< *Gasterosteus*, Girard, Expl. and Surv. for R. R. Route to Pacific Oc., v. 10, Fishes, p. 85, 1858.
< *Gasterosteus*, Günther, Cat. Fishes Brit. Mus., v. 1, p. 2, 1859.
= *Gasterosteus*, Gill, Cat. Fishes E. Coast N. A., p. 39, 1861; Canad. Nat., n. s., v. 2, p. 8, 1865.
< *Gasterosteus*, Sauvage, Nouv. Arch. Mus. d'Hist. Nat. Paris, t. 10, pp. 7, 9, 1874. (Subgenus.)
= *Gasterosteus*, Jordan, Man. Vertebrates Northern U. S., p. 248, 1876.

Gasterosteines with the branchial apertures restricted (the branchiostegal membrane being attached below), and two free divergent spines.

Type, *G. aculeatus* L.

Spinachiinæ.

Synonymy.

Spinachianæ, Gill, Proc. Acad. Nat. Sc. Phila., v. 14, p. 233, 1862.
Spinachiinæ, Gill, Johnson's New Universal Cycl., v. 4, p. 558 (under "Stickle-back"), 1878.

Gasterosteids with a very projecting subtubiform snout, subabdominal ventrals, and elongated caudal peduncle.

SPINACHIA.

= *Les Gastrés (Spinachia)*, Cuvier, Règne Animal, t. 2, p. 320, 1817.
= *Spinachia*, Fleming, Hist. Brit. Animals, p. 219, 1828.
= *Polycanthus*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 242.
= *Gastræa*, Sauvage, Nouv. Arch. Mus. d'Hist. Nat. Paris, t. 10, pp. 7, 29, 1874. (Subgenus).
Gasterosteus sp., Linn., et al.

Spinachiines of unique type.

Type, *S. vulgaris* = *Gasterosteus spinachia* Linn.

AULORHYNCHIDÆ.

Synonyms as family names.

= *Aulorhynchoidæ*, Gill, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 233, 1862.
= *Aulorhynchidæ*, Gill, Arrangement Families Fishes, p. 14, 1872.

= *Aulorhynchidæ*, Jordan & Gilbert, Syn. Fishes, N. Am., pp. 387, 391, 1883.

Fistulariidæ, gen., Günther.

Synonym as subfamily name.

= *Aulorhynchinæ*, Gill, Proc. Acad. Nat. Sci. Phila. [v. 13], p. 169, 1861.

Hemibranchs with the anterior vertebræ little enlarged, an elongated subcylindrical body, elongated tubiform snout; sides with a row of bony shields, and ventrals subthoracic, with a spine and four rays each.

AULORHYNCHUS.

= *Aulorhynchus*, Gill, Proc. Acad. Nat. Sc. Phila. [v. 13], p. 169, 1861.
= *Auliscops*, Peters, Monatsber. K. Preuss. Akad. Wiss., 1866, p. 510, 1866.

Aulorhynchids with a smooth-skinned crown and tube, lateral plates unarmed and hidden in the skin, dorsal spines (25–26) moderately short, and naked back.

Type, *A. flavidus* Gill.

AULICHTHYS.

= *Aulichthys* (Brevoort), Gill, Proc. Acad. Nat. Sci. Phila. [v. 14], p. 234, 1862.

Aulorhynchus sp., Steindachner.

Aulorhynchids with a corrugated crown and rostral tube, lateral plates each armed with a longitudinal posteriorly spinous ridge, dorsal spines (about 25) very short and transversely triangular, and reclining in grooves, behind each of which is a small plate.

Type, *A. Japonicus* (Brev.) Gill.

AULOSTOMIDÆ.

Synonymy.

< *Aulostomides*, Latreille, Fam. Nat. du Règne Animal, p. 129, 1825.
< *Aulostomatidæ*, Cantor, Cat. Malayan Fishes, p. 211, 1850.
= *Aulostomatoidei*, Bleeker, Enum. Sp. Piscium Archip. Ind., p. xxiii, 1859.
< *Aulostomatoids*, Gill, Proc. Acad. Nat. Sci. Phila. [v. 13], p. 168, 1861.
= *Aulostomidæ*, Gill, Arrangement Families Fishes, p. 14, 1872.
< *Aulostomatoidæ*, Cantor, Day, Fishes of India, v. 1, p. 360, 1878.
= *Aulostomatidæ*, Jordan & Gilbert, Syn. Fishes N. Am., pp. 387, 390, 1883.

Bouches en flute, gen., Cuvier.

Fistularidæ, gen., Günther, et al.

Hemibranchs with the first four vertebræ elongated, the form elongated compressed, with an elongated tubiform mouth; the body covered with cycloid scales, with subabdominal ventrals composed of six rays but without spines, and with a series of dorsal spines.

AULOSTOMA.

= *Aulostoma*, Lacépède, Hist. Nat. des Poissons, t. 5, p. 357, 1803.
< *Polypterichthys*, Bleeker, Natuurk. Tijdschr. Nederlandsch Indie, v. 4, p. 608.
Fistularia sp., Linn.
Solenostomus sp., Gronow.

Aulostomids with a much compressed body, rudimentary teeth, 8–12 dorsal spines, opposite oblong dorsal and anal (with 23–28 rays each), and a cuneiform caudal.

Type, *A. chinensis* = *Fistularia chinensis* Linn.

FISTULARIIDÆ.

Synonyms as family names.

< *Siphonostomes*, Duméril, Zool. Anal., 23e fam., p. 138, 1806.
Centrischini? Rafinesque, Indice d'Ittiologia Siciliana, p. 34, 1810.
< *Siphostomia* (*Aulostomia*), Rafinesque, Analyse de la Nature, 20e fam., p. —, 1815.
< *Bouches en flute*, Cuvier, Règne Animal [1re éd.], t. 2, p. 348, 1817; 2e éd., t. 2, p. 267, 1829.
< *Aulostomides*, Latreille, Fam. Nat. du Règne Animal, p. 129, 1825.
< *Centriscides*, Risso, Hist. Nat. de l'Europe Merid., t. 3, p. 476, 1826.
< *Fistularidæ*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 35), 1832; Isis, 1833, col. 1200.
< *Scomberidæ* (*Fistularinæ*), Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 240, 1839.
< *Fistularidæ*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 190, 1840.
< *Fistularioidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, fam. 133, p. xxvi, 1859.
< *Fistulariidæ*, Günther, Cat. Fishes Brit. Mus., v. 3, p. 529, 1861.
< *Fistulariidæ*, Cope, Proc. Am. Assoc. Adv. Sc., v. 20, p. 339, 1872.
= *Fistulariidæ*, Gill, Arrangement Families Fishes, p. 14, 1872. (Named only.)
< *Fistulariæ*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 35, 1873.
< *Fistulariidæ*, Günther, Int. to Study of Fishes, p. 507, 1880.
= *Fistulariidæ*, Jordan & Gilbert, Syn. Fishes N. Am., pp. 387, 388, 1882.

Synonyms as subfamily names.

< *Fistularini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animal Vertebr. a Sangue Freddo, p. 35), 1832; Isis, 1833, col. 1200.

< *Fistularini*, Bonaparte, Nuovi Annale delle Sc. Nat., t. 2, p. 132, 1838; t. 4, p. 190, 1840.

= *Fistularinæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 175, 240, 1839.

Hemibranchs with the first four vertebræ very long; a very elongated and somewhat depressed body; a long tubiform snout; without scales, with the ventrals near the middle, and having five or six rays each, but no spines, and without dorsal spines (the two middle rays of the caudal produced and united into a long filament).

FISTULARIA.

< *Solenostomus*, Klein.

< *Fistularia*, Linn., Syst. Nat., 10. ed., v. 1.

= *Fistularia*, Lac, H'st. Nat. des Poissons, t. 5, p. 349.

= *Channorhynchus*, Cantor, Cat. Malayan Fish., p. 211, (Proposed on account of preoccupation of Fistularia by Donati.)

Fistulariids of unique genus.

Type, *F. tabaccaria* Linn.

MACRORHAMPHOSIDÆ.

Synonyms as family names.

< *Aphyostomes*, Dumèril, Zool. Anal., 5. fam., p. 106, 1806.

= *Centrischini*, Rafinesque, Indice d'Ittiologia Siciliana, p. 34 (33. ord.[1]), 1810.

< *Siphostomia* (Aulostomia), Rafinesque, Analyse de la Nature, 20. fam., p. —, 1815.

< *Bouches en flute*, Cuvier, Règne Animal, t. 2, p. 348, 1817.

< *Aulostomides*, Latre'lle, Fam. Nat. du Règne Animal, p. 129, 1825.

< *Centriscides*, R sso, Hist. Nat. de l'Europe Merid., t. 3, p. 476, 1826.

< *Fistularidæ* (Centriscini), Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio. Distrib. Metod. Animal. Vertebr. a Sangue Freddo, p. 35), 1832; Isis, 1833, col. 1200.

< *Fistularidæ*, Bonaparte, Nuovi Annali delle Sc. Nat., t. 2, p. 132, 1838; t. 4, p. 190, 1840.

< *Fistularidæ*, Bonaparte, Cat. Metod. dei Pesci Europei, pp. 7, 70, 1846.

= *Centriscoidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxiii, 1859.

< *Centriicidæ*, Günther, Cat. Fishes Brit. Mus., v. 3, p. 518, 1861.

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[1] *Macroramphosus* is included in the 35. ord. *Siluridi* (p. 35.)

= *Centriscidæ*, Gill, Arrangement Fam. Fishes, p. 25, 1872.
$<$ *Centrisci*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth.. p. 35, 1873,
= *Centriscidæ*, Jordan & Gilbert, Syn. Fishes N. A., p. 387, 1882.

Subfamily synonyms.

$<$ *Centriscini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 35), 1832 ; Isis, 1833, p. 1200.
$<$ *Centriscini*, Bonaparte, 1850.
= *Centriscinæ*, Gill, Proc. Acad. Nat. Sc. Phila., 1862, p. 234, 1862.
$<$ *Orthichthyinæ*, Gill, Proc. Acad. Nat. Sc. Phila., 1862, p. 234, 1862.

Hemibranchs with the four anterior vertebræ much lengthened; bony plates anteriorly and especially about the back; an elongated tubiform mouth; abdominal ventrals with a spine and several rays; a small distinct spinous dorsal about the middle of the body; with the branchihyals and pharangeals mostly present, the fourth superior branchihyal, and first and fourth superior pharyngeals only wanting.

MACRORHAMPHOSUS.

= *Macrorhamphosus*, Lacépède, Hist. Nat. des Poissons, t. 5, p. 136,
= *Centriscus*, Cuvier, Règne Animal, 1. ed., t. 2, p. 350, 1817.
$>$ *Orthichthys*, Gill, Proc. Acad. Nat. Sci. Phila., 1862, p. 234, 1862.

Macrorhamphosids with an oblong body, graduating into the caudal peduncle, straight back, and about seven dorsal spines.

Type, *M. scolopax* = *Centriscus scolopax* Linn., 1766.

As Messrs. Jordan & Gilbert have recently shown (Proc. U. S. Nat. Mus., v. 5, p. 575, 1883), the *only* species referred by Linnæus at first to the genus *Centriscus*, was the *C. scutatus* (afterwards taken as the type of *Amphisile*), and consequently *Centriscus* cannot be properly used as the designation of the present genus. The name *Macrorhamphosus*, being the first applicable, although imposed by mistake, may be used for it. It is unfortunate that the change should have to be made, and, although fully conversant with the status years ago, I hesitated to propose it. Nevertheless with such excellent authorities as Messrs. Jordan & Gilbert to recognize its necessity, I no longer refuse to accede to the change.

CENTRISCOPS.

= *Centriscops*, Gill, Proc. Acad. Nat. Sci. Phila. 1862, p. 234, 1862.
Centriscus sp., Richardson, *et al.*

× [*Malacoptérygiens*] *Subbranchiens*, Cuvier, Règne Animal, 1re ed., t. 2, p. 211, 1817. (Tribe.)

× *Jugulaires Malacoptérygiens*, Risso, Hist. Nat. de l'Europe, t. 3, p. 214, 1827. (Tribe.)

× *Apodes*, Risso, Hist. Nat. de l'Europe, t. 3, p. 189, 1827. (Order.)

× *Lotes*, Oken, Lehrbuch der Naturgeschichte, 1816.

× *Malacopterygii*, Bonaparte, Giorn. Accad. di Sci., v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 36), 1832; Isis, 1833, col. 1202.

× *Subbrachiani* (*Sternopygii*). Bonaparte, Giorn. Accad. di Scienze, v. 52, (Saggio Distrib. Method. Animali Vertebr. a Sangue Freddo, p. 37), 1832; Isis, 1833, col. 1202.

< *Malacopteryges*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 167, 197, 1839. (As order.)

< *Anacanthini*, Müller, Abhand. K. Akad. Wissensch. Berlin, 1844, p. 199, 1846. (As order.)

< *Gadi*, Bonaparte, Catalogo Metodico dei Pesci Europei, pp. 5, 22, 1846. (As order.)

/ *Physoclysti*, Gill, Cat. Fishes E. Coast N. Am., p. 7, 1861. (As suborder of *Teleocephali*).

< *Anacanthini*, Günther, Cat. Fishes Brit. Mus., v. 4, p. 317, 1862. (As order.)

< *Anacanthini*, Häckel, Generelle Morphologie der Organismen, B. 2, p. cxxvii, 1866. (As suborder.)

= *Anacanthini*, Gill, Arrangement Families Fishes, p. 31, 1872. (As suborder of *Teleocephali*.)

/ *Anacanthini*, Cope, Proc. Am. Assoc. Adv. Science, v. 20, p. 341, 1872.

/ *Scyphobranchii*, Cope, Proc. Am. Assoc. Adv. Science, v. 20, p. 341, 1872.

= *Anacanthini* or *Jugulares*, Jordan & Gilbert, Syn. Fishes N. Am., p. 783, 1882. (As group or suborder.)

Two open questions affect the constituency of the group.

Prof. Cope, in his memorable "Observations on the systematic relations of the Fishes", defined the group, which he referred to his "order" Percamorphi, in the following terms :—

I. "Anacanthini. Basis cranii simple, no tube; post-temporal bifurcate; scapular foramen between scapula and coracoid; superior pharyngeals three, horizontal, third little larger; dorsal fin rays flexible, jointed. Includes the families *Gadidæ* and Macruridæ, both with isocercal caudal vertebræ."

This definition is quite applicable to the typical *Gadidæ* and Macruridæ, but there are several forms which have generally [illegible] with them (and which have even been usually [illegible] to be more nearly allied to the Gadidæ than are the

Macruridæ) which do not exhibit the combination of characters signalized. Such fishes have been designated as the families *Brotulidæ*, *Ophidiidæ*, *Fierasferidæ*, and *Congrogadidæ*. These have the characters assigned by Prof. Cope to his Scyphobranchii, at least as much as the genus *Zoarces* (referred to that group as a genus of Blenniidæ), but none of the genera are mentioned under either title. Probably Prof. Cope had no skeletons of any of the families in question. We are therefore left in doubt (1) whether he would associate them with the *Gadidæ* and *Macruridæ* and modify the characters of the including group Anacanthini, or (2) whether he would refer them to the Scyphobranchii, next to *Zoarces* and the *Blenniidæ* generally.

Messrs. Jordan & Gilbert, in their excellent "Synopsis of the Fishes of North America," incidentally (p. 783, in a foot-note) refer to the "Anacanthini or Jugulares" as a "group or suborder" of Acanthopteri, and conclude the "order Acanthopteri" with the series of families generally combined under the former name. After having first admitted the family *Brotulidæ* (p. 79), they finally referred its constituents to the family *Gadidæ* (p. 794), admitting, however, the families *Congrogadidæ* (p. 790), *Fierasferidæ* (p. 791), *Ophidiidæ* (p. 792), and *Macruridæ* (p. 810). The question now arises whether the last thought of the eminent ichthyologists is an advance on their first thought.

A preliminary investigation into the structure of the Jugular or Anacanthine fishes, leads us to different conclusions from those enunciated by the several great authorities, whose views we have mentioned. That lamentable inattention to anatomy, and poverty of the museums in anatomical preparations and skeletons, which is the opprobrium of the institutions of this country, has prevented anything like an exhaustive examination, and will forbid the rapid progress here of scientific ichthyology till the want is supplied. My own small private collection, supplemented by the data published by others, has alone rendered even the present outline of the system of the Anacanthini possible. The details will therefore have to be filled in when science shall have established itself more thoroughly here, or when a citizen of a more fortunate land shall take up the subject. Enough is now known, however, to almost assure us that the present outline cannot be far out of the way.

Thanks to the kindness of my venerable friend, Prof. Poey, of Havana, I obtained, many years ago, the cranium of the West Indian *Brotula* (*B. barbata*) and briefly indicated the most salient characteristics of the type in a foot-note to an article "On the Affinities of several doubtful British Fishes" (Proc. Acad. Nat. Sci. Phila., 1864, p. 200). The note, published in this rather irregular manner, has doubtless escaped the attention of Messrs. Cope, Jordan and Gilbert, for otherwise they would certainly have recognized the validity of the family Brotuliidæ. The type in question, indeed, has but little affinity with the Gadidæ, and it gives me a pleasure, the greater because it is so rare, to find myself in accord with Dr. Günther in combining it rather with the Ophidiina, Fierasferina and Congrogadina, in contradistinction to the Gadidæ. I must, however, entirely dissent from that gentleman in considering the combination as of simply family value, in associating with them the Ammodytina, and also as to the sufficiency of the diagnosis.

The several groups are distinguishable as follows:—

SUPERFAMILY GADOIDEA.

Synonymy.

> *Gadoidea*, Gill, Cat. Fishes E. Coast N. Am., p. 7. 1873. (Named only.)
> *Macruroidea*, Gill, Cat. Fishes E. Coast N. Am., p. 7, 1873. (Named only.)

Jugulares with the orbito-rostral portion of the cranium longer than the posterior portion, the cranial cavity widely open in front; the supraoccipital well developed, horizontal and cariniform behind, with the exoccipitals contracted forwards and overhung by the supraoccipital, the exoccipital condyles distant and feebly developed, with the hypercoracoid entire, the hypocoracoid with its inferior process convergent towards the proscapula, and the fenestra between the hypercoracoid and hypocoracoid.

GADIDÆ.

Family Synonyms.

< *Jugulaires* ou *Auchénoptères*, Duméril, Zoologie Analytique, p. 118, 1806.
< *Gadinia*, Rafinesque, Analyse de la Nature, p. —, 3e fam., 1815.
< *Metrosomes*, De Blainville, Journal de Physique, t. 83, p. 255, 1816.
X *Gadini*, Rafinesque, Indice d'Ittiolog. Siciliana, p. 11, 1810.
< *Gadoïdes*, Risso, Hist. Nat. de l'Europe Mérid., t. 3, pp. 104, 214, 1826.
< *Gadoïdes*, Cuvier, Règne Animal, 1re éd., 2, p. 211, 1817; 2e éd., t. 2, p. 330, 1829.

< *Gadites*, Latreille, Fam. Nat. du Règne Animal, p. 125, 1825.

< *Gadites*, Stark, Elements of Nat. Hist., v. 1, p. 423, 1828.

< *Gadites*, McMurtrie, Cuv. Animal Kingdom, v. 2, p. 243, 1831.

< *Gadidæ*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 37), 1832.

< *Gadoidea*, Rich, Fauna B., Americana, v. 3, p. 241, 1836.

< *Gadidæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 188, 299, 1839.

< *Gadidæ*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 194, 1840.

> *Brosmiidæ*, Adams, Manual Nat. Hist., p. 104, 1854.

> *Phycidæ*, Adams, Manual Nat. Hist., p. 104, 1854.

X *Merlucciidæ*, Adams, Manual Nat. Hist., p. 104, 1854.

> *Gadidæ*, Adams, Manual Nat. Hist., p. 104, 1854.

< *Gadidæ*, Kaup, Archiv. für Naturgeschichte, Jahr. 1858, B. 1, p. 86, 1858.

< *Gadidæ*, Girard, Expl. and Surv. for R. R. Route to Pac. Oc., v. 10, Fishes, p. 140, 1858.

X *Gadoidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxvi, 1859.

< *Gadidæ*, Günther, Cat. Fishes Brit. Mus., v. 4, p. 326, 1862.

< *Gadidæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, p. 247, 1863.

< *Gadidæ*, Cope, Proc. Am. Assoc. Adv. Sci., v. 20, p. 341, 1872.

= *Gadidæ*, Gill, Arrangement Families of Fishes, p. 3, 1872.

< *Gadi*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 43. 1873.

< *Gadidæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 400, 794, 1882.

Subfamily Synonyms.

X *Merluccia*, Rafinesque, Analyse de la Nature. p. —, 1re S. fam., 1815.

< *Gadini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 37), 1832.

> *Gadinæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 188, 299, 1839.

X *Merluccinæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 188, 300, 1839.

> *Phycinæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 188, 301, 1839.

X *Brosminæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 188, 301, 1839.

X *Gadini*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 1832, 138; t. 4. p. 194, 1840.

> *Lotini*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4. p. 194, 1840.

< *Gadinæ*, Kaup, Archiv für Naturgeschichte, Jahrg. 1858, B. 1, p. 86, 1858.

X *Gadiformes*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxvi, 1859.

> *Gadinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, pp. 229, 243, 248, 1863.

> *Lotinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, p. 230, 1863.

> *Phycinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, p. 230, 1863.
> *Ciliatinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, p. 230, 1863.
> *Brosminæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, p. 230, 1863.
= *Gadinæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 794, 1882.

Gadoidea with a moderate caudal region coniform behind, and with the caudal rays procurrent above and below; submedian anus, moderate suborbital bones, terminal mouth, jugular ventrals, dorsal furniture commencing nearly above the pectoral region, variously developed, and anal confined mostly to the posterior half of the length.

This group is, perhaps, still a composite one, and all the forms retained in it, otherwise called Gadinæ by Messrs. Jordan & Gilbert, do not have the "frontal bone single, normal." The Gadinæ, Phycinæ and Brosminæ (Gill, op. cit.) are thus characterized, and are typical constituents, but the Lotinæ, and apparently Ciliatinæ or Oninæ, have doubled or paired frontals. Unfortunately the only skeletons of these types accessible to me are articulated, and cannot be critically examined. It seems probable, however, that they may be segregated in a peculiar family.

MERLUCIIDÆ.

Family Synonyms.

< *Merluciidæ*, Adams, Manual Nat. Hist., p. 104, 1864.
= *Merluciidæ*, Gill, Arrangement Families of Fishes, p. 3, 1872.
Jugulaires, gen., Duméril.
Gadinia, gen., Rafinesque.
Metrosomes, gen., Blainville.
Gadoides, gen., Risso.
Gadidæ, gen., Bon., Swains., Adams, Günther, Girard.
Gadoidei, gen., Bleeker.
Gadi, gen., Fitzinger.

Subfamily Synonyms.

< *Merluccia*, Rafinesque, Analyse de la Nature, 1re S. fam., 1815.
< *Merluccinæ*, Swainson, Natural History of Fishes, Amphibians and Reptiles, v. 2, pp. 118, 300, 1839.
= *Merluciinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 14, pp. 243, 244, 1863.
= *Merluciinæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 795, 1882.
Gadini, pt., Bon.
Gadinæ, pt.

Gadoidea with a moderate caudal region coniform behind and with the caudal rays procurrent forwards, the anus submedian, moderate suborbital bones, terminal mouth, subjugular ventrals;

dorsal double, a short anterior and long posterior one, a long anal corresponding to the second dorsal; *ribs wide, approximated, and channeled below or with inflected sides, and paired excavated frontal bones with divergent crests continuous from the forked occipital crest.*

BREGMACEROTIDÆ.

Synonymy.

= *Bregmacerotidæ*, Gill, Arrangement Families of Fishes, p. 3, 1872.
Blenniidæ, gen., Richardson.
Gadidæ, gen., Günther, Day.

Gadoidea? with a robust caudal portion truncate or convex behind, almost without procurrent caudal rays above or below, with an antemedian anus, moderate suborbitals, terminal mouth, jugular ventrals abnormally developed; an occipital ray, and behind a continuous dorsal fin, confined to the caudal portion, and an anal nearly similar to the long dorsal.

RANICEPITIDÆ.

Family Synonyms.

= *New Family*, Parnell, Mag. of Zool. and Bot., v. 1, p. —, 1837. (Not named, but indicated.)
= *Ranicepitidæ*, Gill, Arrangement of Fam. of Fishes, p. 3, 1872.
Jugulaires, gen., Duméril.
Gadinea, gen., Rafinesque.
Gadoides, gen., Cuvier.
Gadidæ, gen., Bonaparte, *et al.*
Gadoidea, gen., Bleeker.
Gadi, gen., Fitzinger.

Subfamily Synonym.

= *Ranicepini*, Bonaparte.

Gadoidea? with a moderate caudal portion, coniform behind, and with caudal rays procurrent, submedian anus, moderate suborbital bones, terminal mouth, jugular ventrals, dorsal (typically) double, an anterior small and posterior long one, anal corresponding to second dorsal, and *rudimentary pyloric cæca in reduced number (2).*

MACRURIDÆ.

Family Synonyms.

< *Lophionotes*, Duméril, Zoologie Analytique, p. 129, 1806.
< *Trachinidi*, Rafinesque, Indice d'Ittiolog. Siciliana, p. 12, 1810.
< *Cephalosomes*, Blainville, Journal de Physique, t. 83, p, —, 1818.

= *Lépidoléprides*, Risso, Hist. Nat. des Poissons de l'Europe Mérid., t. 3, p. 242, 1826.
< *Gadoides*, Cuvier, Règne Animal, 1re éd., t. 2, p. 211, 1817; 2e éd., t. 2, p. 330, 1829.
= *Lepidolepridæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 179, 261, 1839.
= *Macruridæ*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 194, 1840.
= *Lepidosomatidæ*, Adams, Manual Nat. Hist., p. 101, 1854.
< *Gadoidei*, Bleeker, Enum. Sp. Piscium Archipel, Indico, p. xxvi, 1859.
= *Macruridæ*, Günther, Cat. Fishes Brit. Mus., v., 4, p. 390, 1862.
= *Macruridæ*, Cope, Proc. Am. Assoc. Adv. Sci., v. 20, p. 341, 1872.
= *Macruridæ*, Gill, Arrangement Families of Fishes, p. 3, 1872.
= *Macrouri*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 43, 1873.
= *Macruridæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 400, 810, 1882.
Gadinia, gen., Rafinesque, 1815.
Gadidæ, s. fam., Bonaparte, 1832.
Gadoidei, s. fam., Bleeker.

Subfamily Synonyms.

< *Trachinia*, Rafinesque, Analyse de la Nature, p. –, 2e s. fam., 1815.
= *Macrourini*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 37), 1832.
= *Macrurini*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 132, 1838; t. 4, p. 194, 1840.
= *Macrurini*, Kaup, Archiv für Naturgeschichte, Jahrg. 1858, B. 1, p. 86, 1858.
= *Macrouriformes*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxvi, 1859.

Gadoidea with an elongated tail tapering backwards and destitute of a caudal fin, postpectoral anus, enlarged suborbital bones, inferior mouth, subbrachial ventrals, a distinct anterior dorsal, and a long second dorsal and anal converging on end of tail.

The several families thus defined are certainly, or in the case of the Ranicepitids and Bregmacerotids, presumably typical Anacanthines, and exhibit the cranial and scapular characteristics signalized for the superfamily Gadoidea. The group thus defined is quite a natural one and perhaps may be deemed worthy of continued isolation under the name Anacanthini or Jugulares, although the propriety of assigning to it subordinal rank is very doubtful.

How very different the other forms approximated to the group are, may be appreciated from the following diagnoses.

SUPERFAMILY OPHIDIOIDEA.

Synonymy.

> *Brotuloidea*, Gill, Cat. Fishes E. Coast N. Am., p. 7, 1873. (Named only.)

> *Ophidioidea*, Gill, Cat. Fishes E. Coast N. Am., p. 7, 1873. (Named only.)

Jugulares with the orbito-rostral portion of the cranium contracted and shorter than the posterior, the cranial cavity closed in part by the expansion and junction of the parasphenoid and frontals, the supraoccipital horizontal and cariniform posteriorly, the exoccipitals expanded backwards and upwards behind the supraoccipital, the exoccipital condyles contiguous, and with the hypercoracoid (scapula, Parker) fenestrate (or foraminate) about its centre, and the hypocoracoid with its inferior process divergent from the proscapula.

These characters are exhibited in the *Brotula barbata* (specimen in coll. T. G.), *Brosmophycis marginatus* (MSS. note), *Pteridium ater* (cranium behind, Emery,[1] f. 27), *Ophidium barbatum* (cranium above, E., f. 26; scapular arch, E., f. 44), *Fierasfer acus* (cranium, E., f. 18–22; scapular arch, E., f. 35–36), *Echiodon dentatus* (cranium, E., f. 23–25; scapular arch, E., f. 37–38), and *Encheliophis vermicularis* (scapular arch, E.,[1] f. 39). The osteology of the Congrogadidæ and Brotulophididæ is entirely unknown and it is only assumed that they belong to this group on account of general agreement in superficial characters.

BROTULIDÆ.

Synonyms as Family Names.

= *Brotulidæ*, Adams, Manual Nat. Hist., p. 104, 1854.

< *Brotuloidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxv, 1859.

= *Brotuloidæ*, Gill, Proc. Acad. Nat. Sci. Phila. [v. 15], p. 252, 1863.

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[1] The references indicated by "E.," are to Prof. Emery's excellent memoir on "Fierasfer" in the Atti della R. Accademia dei Lincei" 1879–80 (pp. 167–254, pl. 1*a*–9*a*). How useful and indeed indispensable this memoir has been may be judged from the references.

OPHIDIIDÆ.

Family Synonyms.

< *Pantoptères*, Duméril, Zoologie Analytique, p. 115, 1806.
< *Ofidini*, Rafinesque, Indice d'Ittiolog. Siciliana, p. 38, 1810.
< *Ophididæ*, Bonaparte, Giorn. Accad. di Scienze, v. 52 (Saggio Distrib. Metod. Animali Vertebr. a Sangue Freddo, p. 38), 1832.
< *Ophidiidæ*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 133, 1838; t. 4, p. 276, 1840.
< *Ophidonidæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, pp. 49, 259,[1] 1839.
< *Ophidiidæ*, Adams, Manual Nat. Hist., p. 105, 1854.
< *Ophidinæ*, Kaup, Cat. Apodal Fish. B. M., p. 153, 1856.
< *Ophididæ*, Rich, Encycl. Brit., 8th ed., v. 12, p. 268, 1856.
< *Ophididæ*, Girard, Expl. and Surv. for R. R. Route to Pacific Oc., v. 10, Fishes, p. 137, 1858.
< *Ophidioidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxv, 1859.
< *Ophidiidæ*, Günther, Cat. Fishes Brit. Mus., v. 4, p. 370, 1862.
= *Ophidiidæ*, Gill, Arrangement Fam. of Fishes, p. 3, 1872.
= *Ophidiidæ*, Putnam, Proc. Boston Soc. Nat. Hist., v. 16. p. 339, 1874.
< *Ofidiidei*, Emery, Atti R. Accad. dei Lincei (3), Fis. Mem., v. 3, p. 168, 1880.
= *Ophididæ*, Jordan & Gilbert, Syn. Fishes N. Am., pp. 400, 792, 1882.

Anguilliformes, gen., Cuvier.
Xiphoides, gen., Risso, 1826.

Subfamily Synonyms.

< *Ophidiini*, Bonaparte, Nuovi Annali delle Sci. Nat., t. 2, p. 133, 1838; t. 4, p. 276, 1840.
< *Ophidinæ*, Swainson, Nat. Hist. and Class. Fishes, etc., v. 2, p. 260, 1839.
< *Ophidiiformes*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxv, 1859.
= *Ophidiina*, Günther, Cat. Fishes Brit. Mus., v. 4, p. 376, 1862.
= *Ofidiina*, Emery, Atti R. Accad. dei Lincei (3), v. 7, p. 168, 1873.

Ophidioidea with chin ventrals, represented by bifid barbel-like filaments, and the anus in the anterior half of the length.

This family is well-marked by the encroachment of the ventrals forwards under the chin and between the rami of the mandible, on which account the species were supposed to have barbels

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[1] At p. 49, regarded as one of the "Families of the Gymnetres; at p. 159 as the 4. subfamily "Ophidoninæ" of the "tribe Gymnetres" (family not differentiated), and at p. 259, mentioned as "3. subfam. Ophidonidæ."

= *Lycodidæ*, Gill, Arrangement Fam. of Fishes, p. 3, 1872.
> *Zoarcæ*, Fitzinger, Sitzungsber. k. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 43, 1873.
Gadidæ and Ophidini, pt., Reinhardt.
Blennioidei and Ophidoidei, pt., Bleeker.
Blennioidæ, pt., Gill, Kroyer.
Lycodidæ and Blenniidæ, gen., Günther.

Subfamily Synonyms.

> *Gymnelinæ*, Gill, Proc. Acad. Nat. Sci. Phila., v. 15, pp. 256, 261, 1863.
> *Zoarcinæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 783, 1882.
> *Lycodinæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 783, 1882.
= *Lycodidæ*, Collett, Norske Nordhavs-Exped. 1876–78; Fiske, p. 77, 1880.
= *Zoarcidæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 400, 1882.
= *Lycodidæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 783, 1882.

Lycodoidea of a more or less anguilliform shape, tapering backwards; dorsal and anal elongated and confluent with caudal, invested in a thick skin; ventrals jugular and rudimentary or suppressed, and branchial apertures lateral and not confluent.

The chief group of this family, or the subfamily Lycodinæ, is a characteristic deep-sea type, and represented by many species varying greatly in elongation, and with the extreme terms tolerably well connected by graduated representatives. Nevertheless, the two sections of *Lycodes*, defined by Prof. Collett (*op. cit.*, p. 84), seem to be entitled to generic rank, and corroborated by other species obtained by the U. S. Commission of Fish and Fisheries. The name *Lycodes* must be retained for the robust species, while *Lycenchelys* may be used as a designation for Collett's second group which have "the body elongate;" height of the body contained from twelve to twenty-four times in the total length. The genera would then be *Lycodes*, *Lycenchelys*, *Lycodopsis*, *Lycodonus*, and *Lycocara* (=*Uronectes*, Gthr.).

In the preceding diagnoses of the superfamilies Gadoidea, Ophidioidea and Lycodoidea, little more is given than what may serve to neatly differentiate the several groups, but the characters given are reinforced by many others, such as the cranial foramina, details in the relations of the bones, and characters of the vertebræ. The relations of the Brotuloidea appear to be almost as intimate, if not indeed more so, with the Lycodoidea than with the Gadoidea. But a comparison of the cranium of a Lycodid with that of a Blenniid, must convince the ichthyotomist

that there is a close affinity between the two. Indeed, it is quite possible, at least, that Prof. Cope might retain his diagnosis of the Anacanthini, and refer the Brotuloid families to his Scyphobranchii by the side of *Zoarces* and his other Blenniidæ. Prof. Emery has also perceived the great differences exhibited in cranial characters by the Ophidioidea from the Gadoidea and has even contended that they should be approximated to the Gobioidea.[1] In view of these facts, it is evident that the group of Anacanthini not only has a very uncertain tenure, but it may have either to be entirely abolished as being an unnatural combination of different types, or to be limited to the Gadoidea.

But it is possible that the group as retained by the most recent ichthyologists may be even more heterogeneous than has been supposed. Several other types have been generally associated with the forms already indicated, but the pertinence of the Ammodytidæ,[2] Ateleopodidæ and Xenocephalidæ to it is doubtful, and it is almost certain that the Gadopsidæ are not at all related to any of the families already discussed; nevertheless, to complete the summary of the families generally referred to the Anacanthini, their synonymy and characteristics are here given:—

AMMODYTIDÆ.

Family Synonyms.

= *Ammodytidæ*, Bonaparte, Catal. Metod. Pesci Europei, pp. 7, 40, 1846.
= *Ammodytidæ*, Gill, Arrangement of Families of Fishes, p. 3, 1872.
= *Ammodytæ*, Fitzinger, Sitzungsber. K. Akad. der Wissensch. (Wien), B. 67, 1. Abth., p. 43, 1873.
= *Ammodytidæ*, Jordan & Gilbert, Syn. Fishes N. Am., p. 414, 1882.

Gadidæ, s. fam., Bonaparte.
Coryphænidæ, gen., Swainson.
Ophidioidei, s. fam., Bleeker.
Ophidiidæ, s. fam., Günther.

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[1] "Attenendomí ai risultati delle mie ricerche anatomiche, io debbo, tra le due opinioni, adottare quella del Canestrini e considerare gli Ofidiidei come affini di Gobioidi, coi quali hanno caratteri comuni assai importanti, in ispecie nella struttura del cranio." Emery, *op. cit.*, p. 169; see also p. 187.

[2] The only skeleton at present accessible to me, has been so badly prepared that I do not venture to base any opinion upon it. I hope soon to have a clean disarticulated one.

Subfamily Synonyms.

= *Ammodytini*, Bonaparte, Nuovi Annali delle Sci. Nat., p. 138, 1838; t. 4, p. 276, 1840.
= *Ammodyteiformes*, Bleeker, Enum. Sp. Piscium Archipel, Indico, p. xxv, 1859.
= *Ammodytina*, Günther, Cat. Fishes Brit. Mus., v. 4, p. 384, 1862:
= *Ammodytinæ*, Gill, Cat. Fishes E, Coast N. A., p. 40, 1861.
> *Argyrotæninæ*, Gill, Cat. Fishes E. Coast N. A., p. 40, 1861.

Anacanthini? with an elongated, almost parallelogrammic body, with a dorsal lateral line, postmedian anus, narrow suborbitals, terminal mouth with protractile jaws, enlarged suboperculum, widely cleft branchial apertures, lamelliform pseudobranchiæ, a long dorsal and long but postmedian anal with articulated rays, low pectorals and no ventrals.

ATELEOPODIDÆ.

Synonyms as Family Names.

= *Ateleopodoidei*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxvi, 1859. (Not defined; made the type of a distinct order—"Ateleopodi—au forte cum Siluris adjungendi.")
= *Ateleopodidæ*, Günther, Cat. Fishes Brit. Mus., v. 4, pp. 318, 398, 1862.
= *Ateleopodidæ*, Gill, Arrangement Families of Fishes, p. 3, 1872.

Synonym as Subfamily Name.

= *Ateleopodini*, Bonaparte, 1850.

Anacanthini? with an elongated tail tapering backwards, but provided with a narow caudal, antemedian anus, moderate suborbitals, inferior mouth, thoracic ventrals reduced to double or simple filaments, a short anterior dorsal only, and a long oval continuous with the caudal.

XENOCEPHALIDÆ.

Synonyms.

= *Xenocephaliformes*, Bleeker, Enum. Sp. Piscium Archipel. Indico, p. xxvi, 1859.
= Appendix to the Anacanthini Gadoidei, Günther, Cat. Fishes in Brit. Mus., v. 4, pp. 318, 399, 1862.
Gadoidei, s. fam., Bleeker.

Anacanthini? with a "small body," a distinct caudal, postmedian anus; head very large, truncated, cuirassed with plates

and armed with spines; jugular? ventrals of five rays and one short dorsal, and a short anal, both near the caudal.

Two other types referred by Dr. Günther to the Anacanthini certainly do not belong to the group and are true Acanthopterygian fishes. They are the Gadopsidæ and Chiasmodontidæ.

GADOPSIDÆ.

Synonymy.

= *Gadopsidæ*, Günther, Cat. Fishes Brit. Mus., v. 4, pp. 317, 318, 1862.
< *Gadopsidæ*, Cope, Proc. Am. Philos. Soc. Phila., v. 13, p. 81, 1873.
Blenniidæ, gen., Steindachner.

CHIASMODONTIDÆ.

Family Synonyms.

= *Chiasmodontidæ*, Gill, Jordan & Gilbert, Syn. Fishes N. Am., p. 964 1882. (Defined.)
Gadidæ, gen., Günther.

Subfamily Synonym.

= *Chiasmodontinæ*, Jordan & Gilbert, Syn. Fishes N Am., p. 795, 1882.

JUNE 24.

Dr. W. S. W. RUSCHENBERGER in the chair.

Fifteen persons present.

A paper entitled "Notes on the Geology and Natural History of the West Coast of Florida," by Jos. Willcox, was presented for publication.

Some Modifications observed in the Form of Sponge Spicules.—Mr. EDW. POTTS remarked that whatever view we may prefer to take as to the position which sponges occupy in the animal kingdom—whether they are regarded as colonial flagellate monads with Saville Kent, or with Haekel take a much higher place among the metazoa, or perhaps, with still greater probability, fill an intermediate place between these, the formation and development of the spiculæ in both the Calcarea and Silicea seem likely to remain for a long time one of the most perplexing problems. Many terms of this conundrum will readily occur to the mind of any one who has worked in this field and observed the spiculæ from their earliest appearance to full maturity, and it is not the design of the present communication to refer to them now more particularly.

An instance, however, in which a singular modification of character has apparently been effected by the chemical condition of the environment seems deserving of mention. Amongst the sponges to which he had alluded in former communications as encrusting certain old pipes, recently removed from the waterworks on the Schuylkill River, in Philadelphia, some portions were much more deeply colored with rust than the others; the statoblasts, particularly, seeming to be mere pseudomorphs of their originals in iron oxide. Fragments of this character were boiled in nitric acid, washed out and mounted for comparison with other matter similarly treated, but free from such discoloration.

The mature normal skeleton spicule of this sponge, *Meyenia Leidyi*, is smooth, robust and shorter than that of any other American species. Very rarely the fine line of the axial channel is visible, but in the specimen under examination the size and exterior appearance of the spiculæ remaining as before, the hardly noticeable channel has become a wide canal, open at both ends, and occupying more than one-half the breadth of the spicule. This does not occur merely in occasional instances, but universally throughout the fragment of sponge so affected. (See fig. 5, Plate IV.)

The birotulate spicules of this sponge also are short and of a

peculiarly substantial appearance, with entire reflexed margins, yet in the present preparation they could with difficulty be detected as mere ghosts of their normal shapes. The two discs rarely remained together, their characteristic entire margins were gone, the rotules being represented merely by a line of very fine rays. The speaker ventured no suggestion as to the influences or the method by which these changes had been effected, but referred the fact to the consideration of students more competent to deal with the mechanical and chemical constitution of these bodies.

Lieut. Thos. L. Casey, Eng. Corps, U. S. A., was elected a member.

JULY 1.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Thirteen persons present.

A paper entitled "On a supposed new species of Cristatella," by Edw. Potts, was presented for publication.

Volcanic Dust from Krakatoa.—Prof. H. CARVILL LEWIS remarked that in connection with the cause of the beautiful red sunsets of last autumn and winter, which had been recently the subject of much discussion in the scientific periodicals, he had been interested in examining some volcanic dust which had been ejected from the volcano of Krakatoa, and which he had received through the kindness of Rev. Wayland Hoyt, D. D., of this city.

This dust, which, on August 27, 1883, fell thickly upon the decks, rigging and masts of the bark William H. Besse, bound from Batavia to Boston, is of a light gray color and harsh to the touch. It is essentially a pulverized pumice, by far the greater part of it consisting of fragments of volcanic glass. These fragments are sometimes twisted, but generally in flat angular transparent scales, which are filled with minute bubbles, and, of course, are isotropic. Angular fragments and crystals of transparent plagioclase, occasionally showing the hemitropic striations, and giving bright colors in the polariscope, together with more irregular and rounded fragments of dark green and brown pyroxenic minerals, probably augite and hypersthene, are scattered very occasionally among the glass particles. Grains of magnetite, often well rounded, also occur, and may be picked out and examined separately by a magnet covered with tissue-paper.

As it is this dust which is regarded as the cause of the universal red skies which followed so soon after the eruption, attempts have been made, both in Europe and America, to discover traces of it in snow or elsewhere,

In the suburbs of Philadelphia, some dust was collected by Mr. Joseph Wharton,[1] this winter, from melted snow, and from the presence in it of certain rounded and filamentous glass particles supposed by him to be volcanic. Some of it had been submitted by him to the speaker for examination. It appeared to be composed of particles of quartz, coal, cinders, vegetable matter, etc., among which are certain glassy hairs and rounded globules. These bear no resemblance to the angular glass fragments composing the Krakatoa dust, which is remarkably free from either filaments or globules; and the supposed volcanic glass particles in the Philadelphia dust are most probably of local origin—from blast-furnaces, foundries, or the like.

Accompanying the specimens of dust from Krakatoa, were extracts from the log of the bark, which present several points of interest. A point of special importance is the record of a sudden barometric fluctuation, due to a great atmospheric wave, which, starting from the volcano at the time of the eruption, has been shown to have "traveled no less than three and a quarter times round the whole circumference of the earth."[2]

Extracts from log of bark William H. Besse, from Batavia towards Boston.

"*Aug. 26.* This day commences with light airs and calms. Light airs throughout the day. At 5.30 P. M., wind hauling ahead, let go starboard anchor with thirty fathoms chain, clewed up and furled all sail. Adam light bore W. 1-4 S. and E. by S. Throughout the afternoon and night heard heavy reports, like the discharge of heavy artillery, sounding in the direction of Java Island. Very dark and cloudy throughout the night, with continual flashes of lightning. Barometer 30.15.

"*Aug. 27.* Commences with strong breezes, and thick, cloudy weather. Barometer 30.12. At 9.30 A. M., pilot left ship. Hove the lead every fifteen minutes. At daylight noticed a heavy bank to the westward which continued to rise; and, the sun becoming obscured, it commenced to grow dark. The barometer fell suddenly to 29.50, and suddenly rose to 30.60. Called all hands, furled everything securely, and let go the port anchor with all the chain in the locker. By this time the squall struck us with terrific force, and we let go starboard anchor with eighty fathoms chain. With the squall came a heavy shower of sand and ashes, and it had become by this time darker than the darkest night. *The barometer continued to rise and fall an inch at a time.* The wind was blowing a hurricane, but the water kept very smooth. A heavy rumbling, with reports like thunder, was heard continually; and the sky was lit up with fork lightning running in all directions, while a strong smell of sulphur pervaded the air,

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[1] See his letter in *Public Ledger*, Jan. 22, 1884.

[2] *Nature*, vol. xxx, p. 12.

making it difficult to breathe. Altogether, it formed one of the wildest and most awful scenes imaginable.

The tide was setting strong to the westward throughout the gale, at the rate of ten knots per hour. At 3 P. M. the sky commenced to grow lighter, although the ashes continued to fall. The barometer rose to 30.30, and dropped gradually to 30.14, when it became stationary. The whole ship, rigging and masts, were *covered with sand and ashes to the depth of several inches.*

"*Aug. 28.* Commences with light airs and thick, smoky weather. Hove up starboard anchor, and hove short on port anchor. Dead calm throughout the day and night. Saw large quantities of trees and dead fishes floating by with the tide; the water having a whitish appearance, and covered with ashes. This day ends with a dead calm, and thick, smoky weather.

"*Aug. 29.* This day commences with calms, and thick, smoky weather. Made all sail throughout the day. Moderate winds, and thick, smoky weather. Passed large quantities of driftwood, cocoanuts, and dead fishes. At 8 P. M., passed Anjier, and could see no light in the lighthouse, and no signs of life on shore. Furled all light sails, and stood under easy sail throughout the night. Day ends with moderate winds and cloudy weather. Barometer 30.14.

"*Aug. 30.* Commences with moderate winds and cloudy weather. At daylight made all sail with a fresh breeze from the westward. Found the water for miles filled with large trees and driftwood, it being almost impossible to steer clear of them. Also passed large numbers of dead bodies and fish. Kept a sharp lookout on the forecastle throughout the day. At 10 A. M., sighted Java Head lighthouse; but the wind hauling ahead, we kept away, and went round Prince Island. Latter part, fresh breezes and *thick, smoky weather.* Friday and Saturday, passed large quantities of ashes in the water. Saturday, crew employed in cleaning ashes off masts and rigging. Water had a green color."

JULY 8.

MR. THOMAS MEEHAN, Vice-President, in the chair.

Eleven persons present.

A paper entitled "Catalogue of Sponges collected by Mr. Jos. Willcox on the West Coast of Florida," by Henry J. Carter, was presented for publication.

The following were ordered to be printed:—

NOTES ON THE GEOLOGY AND NATURAL HISTORY OF THE WEST COAST OF FLORIDA.

BY JOSEPH WILLCOX.

The following notes apply especially to the Counties of Levy and Hernando in Florida. That portion of the Peninsula consists of a fine grained limestone composed largely of foraminifera, several species of which have been determined by Prof. Heilprin. The limestone is covered with sand, in some places with a thin layer only, while, at other localities, wells sunk to the depth of 25 or 30 feet have failed to indicate the presence of rocks. In many places the rocks are exposed above the surface of the ground. They are hard and compact when dry; but, when they are permanently wet, they are comparatively soft, and are eroded with facility. In fact, throughout a large portion of the State numerous and long subterranean caverns abound, that serve as aqueducts to convey the water supplying the many large springs, for which this territory is noted.

The subsidence of the surface ground into these caverns has caused many sink-holes. Three miles south of Gainesville, within a space of less than 100 acres, nearly fifty funnel-shaped sink-holes exist, from 20 to 200 feet in diameter at the top, and from 10 to 50 feet deep.

These are near to Payne's Prairie, a lake covering a space of about forty square miles. This lake has no outlet, and its surface rises and falls, as is usual in such cases, according to the abundance or scarcity of rain.

It covers an area that was dry land a few years ago. The creek, which now supplies water to it, formerly flowed into a sink hole near those mentioned above. This creek undoubtedly was the active agent in eroding the caverns into which the material formerly occupying the space where the sink-holes now exist was precipitated. Some sink-holes are large and the subsidence moderate. Examples of the latter case may be seen in numerous shallow ponds and cypress swamps. Many large lakes probably owe their existence to the same cause.

The limestone is, in some localities, replaced by a chert rock, in which the casts of shells are still visible. This rock forms the

only material suitable for the manufacture of stone implements, that the writer has seen in Florida.

The coast is fringed with a strip of land four to six miles wide that is low, level and rocky, from Cedar Keys to Anclote Key, seventy-five miles farther south.

A large portion of this land is swampy; and much of it is covered with water, when the tide is unusually high; while the highest portion of it is only 3 or 4 feet above the level of high water.

It is covered with a shallow, rich soil, which sustains a dense growth of hard wood, in addition to many palmetto and red cedar trees.

At a distance of from eight to twelve miles apart small rivers empty into the Gulf. They have their sources chiefly in large springs, which are supplied by long, subterranean caverns. They have cut crooked channels through the limestone rocks, not only on the mainland, but through the shoals to the deep water of the Gulf.

These rocks, the foundation of the mainland, extend westward under the water of the Gulf of Mexico; and for the distance of several miles from the shore great shoals exist; making navigation impracticable, except for small vessels. At low tide the rocks are exposed to view in numerous instances, far from shore. In fact such a great number of low islands exist along the coast, separated from each other by shallow bays and creeks, that it is difficult to determine what should be classed as the shore line.

Many of these islands are overflown with water at high tide. In such cases they are covered with mud: those nearest to the sea usually sustaining a dense growth of mangrove trees; while others nearer the mainland are covered with saw-grass and bull-rushes.

A soft and unctious mud covers the bottom to the depth of a few inches in the shoal water; and an abundance of sea weeds thrives there. These afford shelter to vast numbers of mollusks, crustaceans and worms, to the life of which those waters are well adapted.

The coast undoubtedly extended much farther into the Gulf, at a time not very remote. On the bottom of the shoals and rivers, and along the shores, the limestone rocks are eroded in a very rough and uneven manner. No smooth surfaces are to be seen:

nothing but sharp, unsightly projections, depressions and deep holes. Along the rivers the waves make many small caverns under the shore.

East of the narrow, rocky belt, lining the shore, the land is sandy and rises to the height of about 200 feet at a distance of from twelve to twenty miles from the coast. The highest land near the coast is at Mount Lee, in Hernando Co., twelve miles from the Gulf, and four miles east of the source of the Homosassa River.

The summit of this hill is 200 feet above the sea, and it terminates abruptly, on the west side, in a rocky bluff 100 feet high. From the top an extensive view may be obtained of the surrounding country, an opportunity seldom afforded in middle and southern Florida. Under this hill are several caverns which have not been opened for exploration; but the noise from falling stones indicates a considerable depth in them. A rib of a manatee has lately been dug from the soil in a small cave in the side of the hill. The limestone at this place is hard and fine grained; and if found to be free from fissures, it will prove to be a desirable building stone. The surface of this rock is rugged and unsightly; having been eroded in the usual, uneven manner.

About five miles northeast of Mount Lee the writer discovered a second locality of *Nummulites Willcoxi*, at an altitude of nearly 200 feet above the sea. They are associated with *Orbitoides* and *Heterostegina* and *Pecten*, as determined by Prof. Heilprin.

The shore of the Gulf of Mexico abounds with multitudes of shells of king-crabs, suggestive of a great mortality among them. At low tide the writer found one king-crab lying upon its back with *Fasciolaria tulipa* on top of it, eating its vitals. Near by was found another lying on its back, upon which were 25 mollusks (*Melongena corona*) eating it.

In Clearwater Harbor, north of Tampa Bay, the sea-urchins, during the first week in April, are covered with shells arranged upon them with system and dexterity, so that they are obscured from view.

Prof. Leidy, when informed of this habit, suggested that it might have some connection with the process of spawning. This suggestion is plausible, as in the same waters in January, though abundant, none of them were found to be covered with any material. Prof. A. Agassiz[1] states that "the sea-urchins, in

[1] See Seaside Studies in Nat. History, page 101.

Boston Harbor, have a habit of covering themselves with seaweeds, packing it down snugly above them, as if to avoid observation: and this habit makes them difficult to find." In Clearwater Harbor the white shells, with which the sea-urchins cover themselves, make a conspicuous object, so that the animal underneath can easily be found. They evidently do not seek concealment from an enemy, as the seaweeds would more effectually accomplish that object.

The shell mounds of the west coast are very numerous; and they indicate the former favorite camping grounds of the Indians.

The largest accumulation of shells is at Cedar Keys. A portion of that town is built upon the mound; and great quantities of the material, consisting almost exclusively of oyster shells, have been used in grading the streets.

Oysters are very abundant and of good size in the vicinity of Cedar Keys, and along the coast as far as forty-five miles farther south. The following small rivers flow into the Gulf of Mexico near the oyster beds :—Wakasassa, Withlacooche, Crystal River, Little Homosassa, Homosassa and Cheeshowiska.

Near the outlets of these rivers are numerous small islands, too low to be habitable, except when elevated by artificial means. At each river the Indians selected an island for their camping ground, to which they carried oysters; the shells, in the course of a long time, making large mounds. Human bones, stone implements and fragments of pottery are frequently found among the shells.

Prof. Wyman, having examined many fresh-water shell mounds, on and near the St. John's River, states in the Memoirs of the Peabody Academy of Science, vol. i, No. 4, 1875, on page 49, that "Stone chips are not common, and were generally found separately, or only a few together; but in no instance in collections indicating a place for the manufacture of arrow heads or other implements." Such a place for the manufacture of stone implements may be seen on John's Island at the mouth of the Cheeshowiska River. Having visited this island mound several times, the writer has found there at least a half bushel of stone implements, in the various stages of manufacture; and at the present time many bushels of the stone chips may be seen there, all made of the chert rock referred to above.

On this island may also be found shell implements of several patterns, made from the shells of *Busycon pyrum.*

The stone implements found there are similar to those figured on Plate II, in the Memoir referred to, and the shell implements are similar to those on Plate VII of the same. Near Dwight's Landing, on the shore of Clearwater Harbor, is an Indian mound composed chiefly of the shells of *Busycon pyrum* and *Fasciolaria tulipa;* the former greatly predominating in numbers. Nearly all of these shells have a hole in the side near the top, about three-quarters of an inch in diameter, all neatly and uniformly made.

It is presumed that the animal was detached from the shell by the Indians, by means of an instrument inserted through this hole.

ON A SUPPOSED NEW SP CIES OF CRISTATELLA.

BY EDW. POTTS.

I wish to announce the discovery in October last, within the waters of Harvey's Lake, Luzerne Co., Pa., of vast colonies, or, technically speaking, of aggregations of colonies of a species of *Cristatella*, exhibiting some peculiarities that seem to distinguish it from *C. mucedo* of Europe and from both the known American forms.

Harvey's Lake is a beautiful sheet of water, lying at an altitude of about 1200 feet above sea-level, amongst partially wooded hills of no great height, and taking rudely the shape of the capital letter T. Its greatest length is about two miles. The depth throughout the larger part of this extent is said to be very great, increasing rapidly a few feet from the shore. The first groups of this beautiful polyp were found upon a large inclined log or stump in deep water, within one or two feet of the surface. Here the colonies appeared as scattered vermiform masses much longer than those of *C. Idæ* of Leidy, and nearly rivaling in length those of *C. ophidioidia* of Hyatt. The longest were estimated at about six inches. Instead, however of following the sinuous lines, described by the latter author as characteristic of his species, these assumed, generally, single or continuous curves, like a parted letter O or rude C. Afterwards, in three or four instances, we found them occupying entirely novel situations.

The tops of fallen trees or large branches lying 20 or 30 feet from the shore, and spreading to a diameter of 10 or 12 feet, were covered by hundreds or thousands of these colonies, clinging to or twining around every branch and twig, yet with so slight an attachment that the motion of raising a twig above water caused them to drop off by dozens. While hanging temporarily by one end they assumed a spiral form, closely twisting upon themselves. Their gelatinous common ectocyst, nearly a line in thickness, lined the branches as far as we could reach or see. Its persistence upon those twigs brought away with us is rather remarkable, as after remaining seven months in water it is still easily recognizable. It exhibits under the microscope a plexus of fine lines like a very delicate mycelium, which indeed may now have replaced the normal structure.

The pocket lens of the collector was of course insufficient to reveal any distinctive characters in the individuals composing these colonies, and we failed in the attempt to bring any of them alive within reach of our microscopes, so that a full determination of the species has awaited the recent germination of some of the numerous statoblasts then secured. Their death in the glass jar, in which some of the colonies were carried, made it necessary several times during the past winter to change the water and wash out the corrupt matter. On these occasions the statoblasts were saved by pouring the water through a sieve. The winter months passed, and April and May came, but still they did not germinate, and I was on the point of discarding the whole as lifeless when a number of embryo colonies were fortunately discovered upon the sides of the jar.

These consisted of from one to eight polypides and exhibited this constant peculiarity. The cœnœcium, in a lateral view, might be compared in shape to a shoe; the cœnœcial cells, whether few or many, occupying solely the elevated or ankle portion; the other extremity was always prolonged into one of the many forms which fashion has dictated for our foot-covering, from the cylindrical pointed toes of some hundrds of years ago to the abbreviated stumps which still form the Chinese ideal of beauty. This feature was very conspicuous, but as I am unable to compare these young colonies with other species at a similar stage, I hesitate to assume its novelty. In the later hatchings it is far less noticeable, and in the most advanced stages which any of the healthy colonies have reached, the prolongation has ceased to be a prominent feature.

An ounce phial contained a quantity of the statoblasts which were supposed to have lost their vitality by "fouling." These were now washed thoroughly in a sieve and placed in a half-gallon jar of water. In about ten days I was rewarded by finding that they had germinated by scores, and the surface of the water was dotted with tiny groups floating with the disc side upward; the polyp heads and their beautiful plumes of tentacles depending and spreading below.

On removing a number of the statoblasts, firmly held together by their marginal hooks, for more minute examination under the microscope, I found them in all the primary stages of development; from the as yet unaltered condition in which whatever of

life may have quickened their long dormant cells, was hidden from sight by the opaque chitin of their valves, to that in which these had been pushed off to right and left and the neophite had reached forth to discover the nature and limitation of the new scene into which he had entered.

The statoblasts, as in the other species of this genus, are orbicular, reddish brown in color, relatively thick, with rounded marginal annulus and a double series of retentive hooks. The latter spring from circular membranous lines on each side, near the circumference of the chitinous body, and on one side are reflexed from the margin, while those pertaining to the other curve abruptly, partly around the annulus and then become radial in the equatorial plane; their surfaces are roughened or minutely tuberculated. Little difference is noticeable between the diameters or the degrees of convexity of the exposed sides of the statoblast; that, however, to which the longer bent hooklets are attached, is generally the larger, with a single sweeping curve, while the other has often a higher convexity at its centre. The chiton is composed of minute hexagonal cells whose outer surfaces appear to be concave [1] or depressed, but their margins are elevated here and there at the angles, into spinous papillæ, with rounded apices, more numerous near the circumference of the statoblast.

As the germination of the enclosed embryo progresses the sides or valves are forced apart, separating always at the same portion of the margin; the whole annulus remaining attached as before described, while the chitinous rim of the other is drawn out from under it, as a pill-box is separated from its lid. This is in marked contrast with the process by which the valves of *Pectinatella* are separated, as shown in the accompanying diagram.

The rounded edge of the semitransparent cœnœcium now appears and slowly protrudes itself so that it is some hours before the first polypide projects his immature tentacles. In the beginning, and sometimes for several days, the cœnœcium is nearly filled with granular particles of yolk-like matter, opaque by transmitted light and of a light waxen yellow [2] when reflected light is

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[1] Prof. Allman describes the chiton cells of *C. macedo* as *convex* upon their outer surface which thus become "elegantly mammillated." A transverse section of the statoblast shows that the annulus is firmly attached to that side on which the hooks are reflexed, and spreads broadly over the rim or margin pertaining to the opposite valve.

[2] These are white in Pectinatella.

used. These are frequently collected into spherical groups, and one or more may occasionally be seen in the act of circulation or of violent revolution—the result probably of ciliary currents within the cœnœcium. These granular masses adhere to the stomach and other internal organs, obscuring their outlines and making it nearly impossible to detect the appearance of the secondary polypides; they follow, however, so soon after the first, that it is believed that several heads are considerably advanced before the separation of the valves of the statoblasts. The tentacles of the first polypide, however, are generally much better developed when it appears, than are those of the succeeding forms, indicating a nearer approach to maturity. The effect of ciliary action is quite evident in this immature condition, but the cilia themselves are minute and difficult of definition. The granular bodies and groups which obscured the body of the cœnœcium become gradually absorbed, or in some way eliminated, remaining latest in the caudal projection and finally entirely disappearing.

The whole cœnœcium then becomes beautifully transparent, disclosing not merely the structure of the individual polypides even when retracted, but the fine lines of the numerous retractor muscles may be readily traced from their connection with the stomach branchia, to their insertion in the disc or opposite portion of the endocyst. The fact that the insertion of these muscles occur in nearly parallel or radial lines upon the disc of the cœnœcium may account for the term used by writers who speak of the *cells* of the cœnœcium; but there are no cell walls, and, when entirely retracted, the stomachs of the individual polypides pass through the lines of muscular filaments and lie wherever they can find room. This "finding room" for their several personalities is often a matter of considerable difficulty to them, and of no little amusement to the observer, who, when a colony is disturbed will see the first few polypides retire with some appearance of graceful ease, but the laggards must struggle to tuck themselves into a bed where six or eight are already lying, and repeated jerks and jostles are necessary before they can finally hide themselves, as they seem to think, by drawing the transparent coverlid of the endocyst together over their heads.

The cells of the outer layer of the endocyst are in this genus larger and of greater depth than the corresponding series in *Pectinatella;* and in both genera appear to be of the same char-

acter over the whole surface of the cœnœcium, there being no such arrangement of locomotory apparatus upon the lower surface in *Cristatella* as Prof. Allman describes and figures in the case of *C. mucedo.*[1] In both genera, also, by a delicate manipulation of the light under a high power of the microscope may be detected the fine lines of transverse and longitudinal muscular tissue which form the third and fourth layers of Prof. Hyatt's series, and are visible also under the thinner cell structure of the evaginated polypide.

As generally accepted, the ectocyst, which, in *Pectinatella*, forms a solid and constantly thickening mass of gelatinoid matter, is in this genus thrown off as a fugitive film, or, more generally, a pavement layer of effete matter that supports the colonies and upon which their locomotion is effected. When the young colonies have been liberated from the floating statoblasts in my jars, they float, as has been already described, with their discs at the surface of the water, and this delicate, invisible film spreads upon the surface, uniting the neighboring colonies and forming a common basis of support from which they do not appear voluntarily to remove. In a natural situation on a stream or pond the wind or currents would probably soon waft them against some solid substance which they would afterwards colonize and inhabit. As has been said, no especial contrivance appears to exist for facilitating the locomotion of these colonies, and, while their power in this respect is, of course, unquestionable, the writer is inclined to doubt whether it is exercised voluntarily and with a purpose, or is not rather an accidental result of the frequent contractions and expansions of the retractor muscles disturbing the position of alternate portions of the disc. This seems the more plausible, as we do not find in this species any method of prehension in the colonies, but merely a gelatinous or slimy cohesion to the ectocyst.

At maturity the evagination of the polypide in the species under consideration is complete, leaving not only no "invaginated fold" but exhibiting the whole digestive system of the polyp

[1] "In the middle of the flattened under surface is an oval disc resembling the foot of a gasteropodous mollusk. On this disc, which is contractile and admits of frequent changes of shape, the colony adheres to neighboring objects or creeps about on submerged leaves and stems of aquatic plants, etc."

some distance beyond the surface of the cœnœcium. The total length of the digestive tract is rather less than that of the lophophoric arms and about equal to that of the outer rows of tentacles. These are fewer in number than in any other described species, ranging from 52–60.[1] In the great majority of the polyp heads which have been examined the number was 54; far less frequently they range upward through 56 and 58 to 60, in only one instance passing that number. On the other hand the tentacular hooks of the statoblasts are more numerous than in *C. ophidioidea*, and about the same as in the other species.

Three species of the genus have been already described, *C. mucedo*, Cuvier, in Europe, and *C. Idæ*, Leidy, and *C. ophidioidea*, Hyatt, in America. The differences existing amongst them are not considerable, and it admits of question whether all should not be merged under the prior title. In the present condition of the subject it would seem that the species now brought forward is at least as clearly differentiated from any of the former ones as they are from each other. I will therefore name it, provisionally, *Cristatella lacustris*.

EXPLANATION OF PLATE IV.

FIG 1 represents a transverse section through the centre of a statoblast of this species, *Cristatella lacustris*; *a*, *a*, the exposed chitinous surfaces of the valves; *b*, *b*, the reflexed; *c*, *c*, the bent, incurved retentive hooks; *d*, *d*, section of the annulus, or ring of air cells surrounding the chitinous body of the statoblast; *e*, *e*, the part of the rim at which the valves separate at the time of germination, as is shown on a larger scale in

FIG. 2, which represents one end of the section of a similar statoblast in the act of separation, the parts indicated by letters corresponding to those on fig. 1, with the addition of *f*, a delicate film which is being stripped from the under surface of the annulus, and *g*, *g*, which suggest the relative sizes and frequency of the papillæ upon the exposed surface of the valves.

FIG. 3 exhibits for comparison a corresponding section of the statoblast of *Pectinatella magnifica*, Leidy, lettered as before; *a*, *a*, the exposed surface of the valves; *b*, *b*, the single series of anchorate hooks; *d*, *d*, sections of the annulus, itself divided by the line *e*, *e*, along

[1] In *C. mucedo* and *C. Idæ* these are said to be "about 80." In *C. ophidioidea*, "not above 90."

which the separation of the valves in this genus is effected, as shown in

FIG. 4, much the larger portion of the annulus with all the hooks (which are formed by expansions of its dermal surface) remaining upon one side, and a smaller part, composed of coarser air cells upon the other. It will be noticed that in *Pectinatella* the annulus is formed of two distinct series of cylindrical cells, short upon one side of the separating line, several times this length upon the other. The corresponding cells of *Cristatella* are much more complicated, being formed about numerous transverse lines upon the internal surface. The figures have been carefully drawn by the aid of the camera lucida.

FIG. 5. Outline views of the skeleton and statoblast spicules of the sponge *Meyenia Leidyi*: *A*, the normal skeleton spicule; *B* and *C*, side and end views of the normal birotulate; *a*, *b*, *c*, the corresponding features as modified by their environment upon the iron pipes as described.

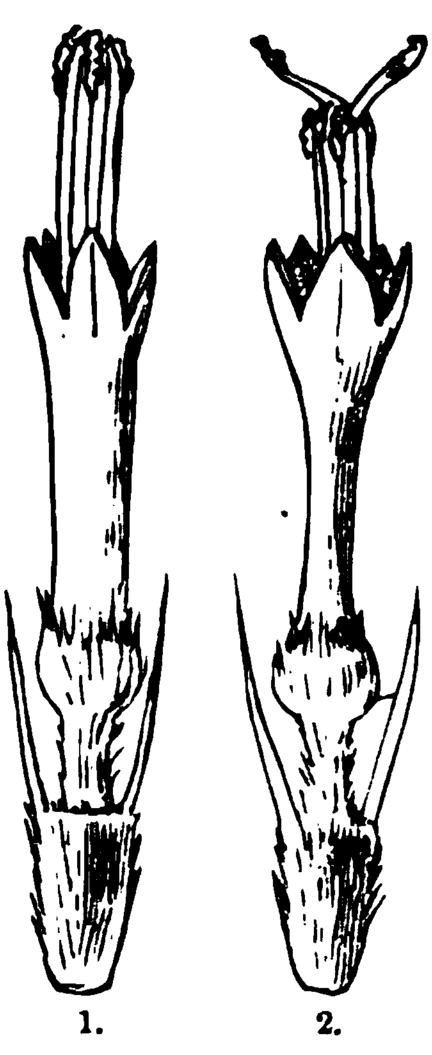
JULY 15.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Fifteen persons present.

A paper entitled "The Geology of Delaware," by F. D. Chester, was presented for publication.

On Elasticity in the Filaments of Helianthus.—Mr. THOMAS MEEHAN remarked that in many composite flowers the pollen is ejected from the apex of the staminal tube, and it became a matter of interest to ascertain the mechanism by which this is accomplished. The flowers of compositæ are much frequented by pollen-collecting insects. Honey-gatherers seldom resort to them. It is difficult on this account to watch the flow of pollen in the open air, as it is collected by the insects as fast as it appears. Some flowers of *Helianthus lenticularis*, Dougl., were gathered, and for the purpose of study placed in saucers of water in a room where insects could not disturb them. In this way it was observed that after the corolla tube had reached its full length, very early the following morning the staminal tube commenced to grow beyond the mouth of the corolla, and by about 9 A. M. had extended to a distance of about one-fourth the whole length of the corolla. The pollen then commences to emerge through the upper portion of the staminal tube, which, the stamens narrowing, has the apices free. During the day the pollen continues to pour out, till by nightfall a large amount has accumulated at the apex of the tube. A floret at this stage of growth is represented by fig. 1. The morning of the second day the arms of the pistil emerge and commence to expand, and at once the staminal tube begins to descend, exhibiting at the end of the second day the appearance indicated by fig. 2. By the end of the third day, the staminal tube has retired entirely within the tube of the corolla, and with the pistil, commences to wither. A careful examination shows that through the whole course the column of united anthers remains entirely of the same length. It is the filaments only which are elastic. These stretch fully one-half their length. They are attached to the tube of the corolla at the inflated portion a short distance above the achene, and extend to about midway between this point and the end of the tubular portion at the base of the limb; but when the anther tube is extended as described in fig. 1, the filaments occupy the



1. 2.

whole of this space. This pollen could fall on the stigma of the flower of the previous day, but as the stigma is already covered by pollen of its own, other pollen is hardly likely to be of much service; and even if this outer circle did profit by the pollen of the inner, it would not be cross-fertilization in any legitimate sense of the word. We may say emphatically that the arrangements favor self-fertilization.

An interesting feature is the change in the form of the floret on the second day of expansion. At the point where the stamens are inserted on the corolla, the tube is somewhat inflated and covered by short hair. On the first day this inflated portion is elongated, and the whole tube uniformly cylindrical, as in fig. 1. On the second day the inflation is depressed, and the corolla hypocrateriform as in fig. 2. This is probably owing to the partial withering of the corolla, but it is worth noting as a guide in the study of the florets of compositæ—the normal form is that exhibited before the anthers mature.

The extension of the staminal tube is evidently mechanical, and is due solely to the upward growth of the stigma, which, partly it seems by the incurved points of the stamens, and partly perhaps by the expansion of the arms of the pistil, is able to carry the tube up with it. This force being removed as soon as the arms emerge, the elastic stamens draw the tube down again to its normal location. This portion of the observation was made by Mr. Alois Lunzer, the artist of the *Flowers and Ferns of the United States*, then engaged in making a painting of the flower for that work.

The effect of this process is to render the plant strictly a self-fertilizer. The arms of the pistil are covered with rigid hair having an upward direction. By the pushing upwards of the pistil in its endeavor to escape from the embrace of the stamens, these hairs brush the pollen upwards, and it is in this way that the pollen is forced through the fissures at the apex as already described. When the arms emerge, they are completely covered with own-pollen, which remains till the stigmas mature.

Helianthus lenticularis is the common annual sunflower of the Western plains, and believed by Professor Asa Gray to be the parent of the garden sunflower. This is not in bloom at the present date. One species, *Helianthus hirsutus*, is in bloom, and exhibits similar features, and they are probably characteristic of the whole genus, and perhaps of other composite plants. In *Centaurea* the apex of the anther tube is closely united, and is taken up with the development of the pistil, which finally escapes through a rupture at the side. But in this case there seems to be a cotemporaneous growth of the filaments. At any rate there is no elasticity, and the staminal tube is not drawn back to the tube of the corolla. Pollen is, however, brushed out by the stigmatic hair, and each floret receives own-pollen as in *Helianthus*.

The following was ordered to be printed:—

CATALOGUE OF MARINE SPONGES, COLLECTED BY MR. JOS. WILLCOX, ON THE WEST COAST OF FLORIDA.

BY HENRY J. CARTER, F. R. S., ETC.

The fragments of the sponges collected by Mr. Willcox which reached me from Philadelphia on June 12, 1884, are all numbered, 1–59, and have been taken from specimens which, bearing the same numbers, have been retained at Philadelphia for identification, when the result of my examination shall have been received; hence the numbers in the catalogue will be found to correspond with those on the specimens at Philadelphia.

It should be remembered that they are all *dry* specimens, and that what I have to examine are *only* "fragments," hence there is very little to be said of each beyond name, form, consistence and color, together with the form and dimension of the spicule respectively, while they are arranged in accordance with the classification that I have proposed in my "Notes Introductory to the Study and Classification of the Spongida," published in the Annals and Magazine of Natural History, for 1875, vol xvi, p. 1, etc.[1]

Catalogue.

ORD. II. CERATINA.

FAM. 2. APLYSINIDA.

No. 19. *Aplysina cauliformis*, Crtr. ("Annals and Mag. Nat. History," 1882, vol. ix, p. 270).

ORD. III. PSAMMONEMATA.

FAM. 1. BIBULIDA.

Group 2. PARASPONGIOSA.

No. 41. *Paraspongia* ?——sp. Allied to the officinal sponge, but with more arenaceous (sand-bearing) fibre.

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[1] ABBREVIATIONS.—"Ann." for Annals and Mag. of Nat. Hist.
"Bk." for Bowerbank, monograph of British Spongiada, vol. iii.
"Sdt." for Schmidt.

Measurements of the spicules those of the *largest present*, showing their dimensions across and longitudinally.

FAM. 2. HIRCINIDA.

Group 3. HIRCINIOSA.

No. 23. *Hircinia* ? —— sp. Massive, erect, lobate. Surface even, minutely reticulated; projecting arenaceous tags; consistence resilient. Color now brown.

No. 26. *Hircinia* ? —— sp. Fragment too insignificant for description.

No. 31. *Hircinia tubulosa*, Crtr. Consisting of a conical mass of erect tubular processes. Consistence resilient. Color light sponge. Fibre scantily cored with arenaceous substance (named after its form).

No. 36. *Hircinia* ? —— sp. Sessile, with solid cylindrical erect branches or processes interunited. Consistence resilient. Color now sponge-brown. ? = No. 23. (*Note.*—As the fibre of these *Hirciniæ* was invested with sarcode different from the color of the fibre itself, there is no saying what color the latter was in its natural state.)

No. 52. *Hircinia* ? —— sp. Sarcode destroyed by *Spongiophaga communis*, Crtr. (See "Parasites of the Spongida," Ann., 1878, vol. ii, p. 168.) Look at the white substance under a microscope, to see the filaments of the parasite.

No. 53. *Hircinia* ? —— sp. Branched; branches solid, cylindrical.

No. 54. *Hircinia* ? —— sp. Has grown over sedgy leaves.

No. 55. *Hircinia* ? —— sp. Sessile, composed of erect conical tubes.

Group 16. ARENOSA.

No. 59. *Spongelia*, Sdt., ? *avara*, Sdt.

No. 57. *Spongelia avara*, Sdt. Red sarcode (Sp. Adriat. Meeres, p. 29, taf. 3, fig. 6).

No. 51. *Spongelia*, Sdt. ? —— sp. = *Dysidea*, Bk. Fragment much worn.

No. 44. *Spongelia*, Sdt. ? —— sp.

No. 43. *Dysidea*, Bk. Like No. 39, but fibrous. ? *Spongelia*, Sdt.

No. 24. *Spongelia*, Sdt., ? *pallescens*, Sdt. (Sp. Adriat. Meeres, p. 28). *Dysidea*, Bk.

No. 39. *Dysidea tenerrima*, Crtr. Merely sarcode and sand producing "columnar" structure. No fibre; thus bearing much the same relation to the *Hirciniosa* that the Holorhaphidota do

to the Rhaphidonemata, viz., a minimum of Kerasine (named after its structure).

ORD. IV. RHAPHIDONEMATA.

FAM. 1. CHALINIDA.

Group 1. DIGITATA.

No. 13. *Chalina oculata*, Bk. A delicate growth.
No. 25. *Chalina oculata*, Bk. A form of.
No. 28. *Chalina oculata*, Bk. Has grown over woody stems.
No. 29. *Chalina oculata*, Bk. Short-branched delicate growth.
No. 42. *Chalina oculata*, Bk. Form of.

FAM. 2. CAVOCHALINIDA.

Group 6. ACULEATA.

No. 22. *Tuba sororia*, Duchass. de Fonb. et Michel. (Spongiares de la mer Caraïbe, Pl. 8, fig 2. Harlem, 1864. Also see "Ann." 1882, vol. ix, p. 277, under " Cavochalinida," W. Indian Sponges).

No number. *Tuba sororia* (D. et M., Pl. 8, fig. 2). Covered. with empty holes, formerly the abodes of a parasitic polyp.

ORD. V. ECHINONEMATA.

FAM. 1.

Group 4. ECHINOCLATHRATA.

No. 16. *Echinoclathria* ? —— sp. Dense mass of erect, small, round, short-jointed branches, polychotomously dividing and ending in short processes with rounded terminations; knotty on the surface, chiefly from the presence of a small parasitic polyp. Consistence hard. Color now gray. Texture dense. Spicule of one form only, viz.: acute, short, robust, sub-capitate, the shortest internally and the longest echinating the fibre. Size, about 14 by 1—1800 in. (Like *Clathria coralloides*, Sdt., Sp. Adriat. Meeres, taf. v, figs. 10 and 11.)

No. 27. *Echinoclathria* ? —— sp. The same as No. 16, but with compressed interuniting branches ending in pointed terminations, but no parasitic polyp. Spicule about 18 by 2—1800 in.

No. 30. *Echinoclathria* ? —— sp. Fragment too insignificant for general description. Compressed, interuniting branches, ending in pointed divisions. Consistence firm. Color light sponge-yellow. Fibre short-jointed, bearing internally and externally capitate acuates, the latter the longest and projecting in

tufts, mixed with a small echinating, spinous acuate (? *Dictyocylindrus*, Bk.).

No. 37. *Echinoclathria?* —— sp. Dense mass of compressed, proliferous, interuniting branches arising from a contracted base, growing on the valve of an *Arca*, terminating in compressed, somewhat expanded divisions. Surface subhispid. Consistence hard, tough. Color now brown. Bearing a parasitic polyp (*Palythoa*). Fibre short-jointed, amber-colored, bearing three forms of spicules, viz.: 1, robust, acuate with globular tuberculated head, about 23 by 2—1800 in. in its greatest dimensions; 2, long smooth acuate, 20 by ½—1800 in.; 3, echinating spicule, clavate, spined, small, 6 by ½—1800 in. (*Note.*—If the "tuberculated head" is not an accidental form, it is a markedly distinguishing character.)

No. 38. The same as No. 27.

No. 46. *Echinoclathria?* —— sp. Fragment useless for general form. Flimsy branched, interuniting, ridged. Consistence firm. Color now whitish gray. Fibre tough, short-jointed, amber-colored, bearing two forms of spicule, viz.: 1, large, long and short robust acuates, less in diameter at the large end than in the middle of the shaft; 2, echinating, short spinous acuate.

FAM. 2. AXINELLIDA.

Group 6. MULTIFORMIA.

No. 6. *Reniera digitata*, Sdt. (Spong. Adriat. Meeres, p. 75, taf. 7, fig. 11.) Massive, sessile lobate. Surface cellular, roughened by ridges and small processes. Consistence firm. Color orange. Structure cellular. (? A species of the genus *Higginsia*, Higgin, "Ann.," 1877, vol. 19, p. 291; vol. xiv, fig. 1.)

No. 7. *Higginsia coralloides*, Higgin ("Ann.," l. c.).

No. 15. *Axinellid*, ? gen. et sp. Fragment shreddy, branching, tough, brown color. Fibre short-jointed, very tough and amber-colored, hispid, bearing three forms of spicules, viz.: 1, robust, simple, acuate, long and short; 2, fine, long, setaceous, acuate; 3, small, navicular anchorate, flesh-spicule. The acuates are situated partly in and partly projecting from the fibre echinatingly, with the anchorate plentifully scattered about their base of attachment. (? *Clathria* Sdt., Sp. Adriat. Meeres).

No. 35. *Axinella polypoides*, Sdt. (Sp. Adriat. Meeres, p. 3, taf. 6, fig. 4).

No. 45. *Higginsia coralloides*, Higgin ("Ann.," l. c.). . Erect

branches, compressed interuniting, roughened by small projecting processes. Consistence now hard. Color whitish gray, spicules of two forms, viz.: 1, large acerate, smooth, 40 by 2—1800 in.; 2, small acerate, spinous, partly in and partly out of the fibre, projecting echinatingly from the surface.

Ord. VI. HOLORHAPHIDOTA.

Fam. 1. **RENIERIDA.**

Group 1. Amorphozoa.

No. 5. *Halichondria panicea*, Bk., attached to sea-weed, covered with white *Melobesia*.

No. 12. *Halichondria panicea*, Bk.

No. 34. *Halichondria panicea*, Bk.

No. 58. *Halichondria panicea*, Bk., much worn.

Fam. 2. **ISODICTYOSA.**

No. 17. *Isodictya*, Bk.? —— sp. Fragment of a branch. Consistence crumbly. Color white. Spicule acerate, 11 by $\frac{3}{4}$—1800 in. (Where the spicule is acerate, which is generally the case, the species are ill-defined, *as yet.*)

Group 3. Thalyosa.

No. 48. *Reniera?* —— sp. Fragment of a cylindrical, solid branch, in which the fibre is entirely composed of small acerate spicules, about 13–1800 in. long. (These species, for the foregoing reason, are, as yet, ill-defined, except where their general form is peculiar.)

No. 49. The same.

Group 6. Halichondrina.

No. 32. *Halichondria incrustans*, Mihi. Variety with "angulated" (Bk.) anchorate and smooth acuate. Consistence crumbly. Color white. Fragment massive, attached to a dark green, dry, gelatinous, now hardened mass, which, if not one of the "Carnosa," is probably the remains of a compound tunicated ascidian.

Suberites par excellence. Groups 10, 11 and 12. Cavernosa, Compacta, Laxa.

10. Cavernosa.

No. 3. *Suberites?* —— sp. Fragment useless for general form, as the whole is broken down into a mass of spicular pulp and fibre. Color yellowish. Spicule of one form only, viz., pin-like; shaft smooth, slightly fusiform and curved; head oval; size, 30 by 1—1800 in. (? = No. 18.)

No. 10. *Raphyrus Griffithsii*, Bk. Branched tubular variety, therefore might be designated "ramotubulata," Crtr. (The first instance of *this form* that I have seen.)

No. 11. The same, but the usual massive, solid form. N. B.—It is *Cliona celata*, which, after having destroyed the oyster-shell in which it generally burrows, grows into the *free* form called by Dr. Bowerbank "*Raphyrus Griffithsii*" (Mon., vol. iii, pl. 64).

No. 18. *Suberites?* —— sp. Fragment branched and interuniting most irregularly. Surface covered with short warty and digitiform processes. Consistence light corky. Color ochre-yellow. Structure cellulo-cavernous. Spicule of one form only, viz., pin-like; shaft smooth, slightly fusiform and curved; head oval, often followed towards the shaft, by an annular inflation; size, 30 by 1—1800 in.

No. 33. *Suberites?* —— sp. Fragment useless for general form; further than that it is very irregular and interuniting, suberite-like. Consistence firm. Color white. Structure cancello-cavernous. Spicule of one form only, viz., pin-like; shaft smooth, slightly fusiform and curved; head globo-conical; about 65 by 1—1800 in.

No. 1. *Suberites?* —— sp. Massive, erect, sessile, terminating in small, conical processes. Consistence now firm. Color gray outside, yellowish inside. Structure cancello-cavernous. Spicule of one form only, viz., pin-like; shaft smooth, slightly fusiform and curved; head nearly oval; point obtusely rounded; size 25 by 1—1800 in. in its greatest dimensions. (If the obtuseness of the point is not accidental, this is a good character.)

11. Compacta.

No. 4. *Suberites?* —— sp. Taking the form of the Serpula-tubes over which it has grown, interuniting and enclosing shells. Consistence hard now and compact. Surface villous. Color yellowish gray. Spicule of one form only, viz., pin-like; shaft smooth, slightly fusiform and curved; head oval, often prolonged posteriorly; size 50 by 1—1800 in.

No. 8. *Suberites?* —— sp. Taking its form from the sedgy leaves over which it has grown. Consistence cheesy, now hard. Color greenish outside (adventitious ?), yellowish within. Like *Hymeniacedon carnosa*, Bk., in consistence and structure, if not in the form of the head of the spicule.

No. 40. *Suberites ?* —— sp. Irregularly branched, interuniting, ending in round-topped processes. Consistence compact. Color reddish yellow. Spicule of one form only, viz., pin-like; head globular with posterior projection, tricuspid like in profile. (? *Suberites marsa*, Sdt., Sp. Adriat. Meeres, p. 67, taf. 7, fig. 2.)

12. LAXA.

No. 20. *Halichondria sanguinea*, Bk. (Mon., vol. iii, pl. 32, fig. 5).

FAM. 13. DONATINA.

No. 47. *Tethya lyncurium*, Bk. (pl. 15, fig. 17, op. cit.). Robust form with large cavernous excavations on the surface, and bundles of spicules sunk in the dry, dark, chondroid tissue.

FAM. 14. GEODINA.

No. 21. *Geodia tuberculosa*, Bk. (Proc. Zool. Soc., 1872, p. 676, pl. 46).

No. 50. The same. Cylindrical fragment.

ORD. VIII. CALCAREA.

No. 9. *Ascaltis Lamarckii*, Hæckel (Die Kalkschwämme, vol. 2, p. 60, Atlas, taf. 9, fig. 5). Massive, growing among sand and round the stems of sea-weed. Enveloping sand. (*Clathrina*, Gray.)

Numbers absent, viz., 2, 14 and 56.

OBSERVATIONS.

Lest it should be thought that it is only necessary to present a fragment of a sponge to have its name and description pointed out as readily as this might be done with a plant in botany, the former being expected from the accumulated product of a few years, while the latter is one of centuries, I would append the following remarks on the above "Catalogue":—

The family of *Hircinida* requires to be generally reviewed, but the time for this has not arrived, since if not by actual specimens preserved when fresh in a *wet* state, it must be done by a review of all the illustrated descriptions of this kind that have been published; while considering that the specimens of *Hircinida* are exceedingly numerous and *very much* alike, nothing but an opportunity of this kind holds out any hope of their ever being collated, divided and finally arranged in such a manner as would be useful to the student. In the spiculiferous sponges the form of the spicule often facilitates this, but in the *Hircinida* generally,

when divested of the sarcode, which often has a particular color, there is absolutely nothing left but the horny fibre covered with a heterogeneous assemblage of foreign objects, viz., sand, fragmentary sponge-spicules and other microscopic bodies, which vary in amount and kind with those which are most plentiful in the locality where the sponge may be growing, if we except the general form which the skeletons composed of this fibre may retain.

The *Suberites par exellence*, too, like the *Hirciniæ*, require a similar treatment, for here the skeletal spicule, being for the most part simply *pin-like*, is so similar and so slightly varied in form, that, in most instances, this alone would be insufficient for distinction. However, the skeletal spicule is often accompanied by a flesh-spicule of a spini-spirular or other form, which lessens the difficulty; but they can seldom be seen without mounting a microscopic fragment in balsam, when the transparency renders them (if there are any) plain, which the *wet* sarcode previously rendered obscure. This should be done with all the specimens *above mentioned*, as it involves an amount of time which I now have not at my disposal; hence can only recommend the student to consult my initiatory attempt to do this in the "Annals" of 1882 ("West Indian Sponges," etc., vol. 9, p. 349, etc., pl. xii, figs. 25–30).

See also, for the group Donatina and species *Donatia lyncurium*, "General observations" (Ib. ib., p. 358, etc.).

In my division of the Echinonemata, the first groups of the families Ectyonida and Axinellida respectively, viz., "1" and "6" *i. e.* "Pluriformia" and "Multiformia" are merely *provisional* terms for including a vast number of species which hereafter will have to undergo description, illustration and division, when they shall have been usefully collated, etc., after the manner already mentioned, but so much time, taste, labor and opportunity will be required for this, that many years must pass before it even approaches completion.

The number of species of sponges that exist and have still to be discovered has been chiefly foreshadowed to me by the *dry* specimens in the British Museum, upon which my proposed "Classification" has been based, but cannot be put forth with any certainty under such circumstances, more especially the subdivision of the orders.

JULY 22.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Eleven persons present.

JULY 29.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Eight persons present.

Sexual Characteristics in Zinnia.—Mr. THOMAS MEEHAN, referring to some so-called double Zinnias on the table, remarked on the change of sexual character which followed the change of a tubular to a ligulate floret This was not confined to *Zinnia*, but occurred in *Dahlia*, and, he believed, all composite flowers. It must be a well-known fact, but had not, so far as he knew, been placed on record. It was well worthy of study by those interested in the laws of sex. In *Zinnia* a single ligulate floret would often be surrounded by tubular and hermaphrodite ones; but it would have the purely pistillate character of the ray florets. In like manner, when, in the double Dahlia, the tubular florets became ligulate, the neutral character of the ray florets followed with them. It was evident that in these cases there was an intimate connection between the form of the floret and its sexual character. There was even a difference in the form of the akene in the different florets of *Zinnia*. The ligulate female floret had a broad akene, tapering at the summit, and with the apex very hairy; while the akene of the tubular hermaphrodite floret was truncate, and entirely smooth.

He made some further remarks on the growth of the floret in connection with that of the staminal tube. In many compositæ the growth of the pistil continued for a day or two after the corolla had ceased to grow, pushing up often to a length double that of the corolla. In *Zinnia* the growth of the floret was enormous on the last day, often doubling its previous length in twenty-four hours. It always remained longer than the pistil, until it withered away, when the expanded arms of the pistil were exposed. The anther cells burst before the floret opened, and, though the arms could not expand, enough pollen entered by the stigmatic fissure to ensure self-fertilization.

The following was ordered to be printed:—

DESCRIPTION OF NEW SPECIES OF TERRESTRIAL MOLLUSCA OF CUBA.

BY RAFAEL ARANGO.

Choanopoma uncinatum Arango (fig. 1).

Testa subperforata, oblongo pupæformis, teniuscula, truncata, filoso costata, furcescenti-albida, seriebus macularum rufarum longitudinaliter ornata; sutura profunda, costis excurrentibus incrassatis albido-dentata; anfr. superst. 4–5 convexiusculi, ultimus antice solutus, dorso carinatus; apertura verticalis, ovalis; peritrema duplex, internum breve, externum dilatatum, lateri dextro latiore, undulato, in angulo supero uncinato reflexum. Operculum normale.

1.

Long. 16 mill.; diam. 7 mill.; apert. 4 mill.

Habitat.—*San Juan de las Lleras*, prope Villaclara.

Simillimum *Tudoræ Moreletianæ*, differt operculo *Choanopomatum* et forma altera peritrematis.

Cylindrella assimilis Arango (fig. 2).

Testa simillima *Cyl. arcustriatæ*. Differt statura magis cylindrica, costis minus confertis, fortioribus; fasciis spadicea suturam anfractus sequentis tangente et prope peri trema expansum terminante (magis conspicua quam in *arcustriata*). Anfractus 12 testæ integræ.

Long. 23–26 mill.; diam. 6 mill.; apert. 4 mill.

Habitat.—*La Iagua*, prope La Palma in provincia Pinar del Rio.

2.

Cylindrella contentiosa Arango.

Testa vix rimata, fusiformi-turrita, fusco-cornea, pallidæ pauce variegata; spira sursum sensim attenuata; truncata; sutura subcrenulata; anfr. superst. 14–15 planulati, ultimus adnatus, basi filoso-carinatus; apertura subcircularis; peritrema undique æqualiter expansum, album.

Long. testæ truncatæ 14–16 mill.; diam. 3 mill.

Columna interna lamina unica acuta oblique circumvoluta.

Habitat.—*San Juan de las Lleras*, prope Villaclara.

Cylindrella Lajoncherei Arango.

Testa fusiformi-elongata, gracilis, subtruncata, tenuis, sub-oblique costata, diaphana, albida; anfr. superst. 15–17, ultimus solutus, deorsum protractus; sutura simplex; apertura oblique circularis, peritrema undique breviter expansum.

Long. 15–17 mill.; diam. 2½ mill.

Columna interna filoso-torta.

Habitat.—*San Juan de las Lleras*, prope Villaclara.

Similis *Cyl. Philippianæ*, differt forma longiori, costis remotioribus et colore albido (nec fusculo-variegato).

Cylindrella Thomsoni Arango (fig. 3).

3.

Testa similis *Cyl. coloratæ* (vide descriptionem) sed differt statura magis cylindrica, colore corneo, testa pellucida, fascia spadicea solummodo in anfractu ultimo visible. Anfractus 14 testæ integræ.

Habitat.—"*La Iagua*," prope La Palma in provincia Pinar del Rio.

Cylindrella infortunata Arango (fig. 4).

Proc. Acad. Nat. Sc. of Phila., 1882, p. 106.

4.

Testa non rimata, subfusiformi-turrita, tenuis, diaphana, chordato-costata, albido-cornea; spira breviter truncata; sutura profunda, non crenulata; anfr. superstites 12, planiusculi, ultimus breviter solutus; basi obsolete carinatus; apertura subovalis; peritrema expansiusculum, album.

Longitud. testæ truncatæ 13 mill.; diam. 3 mill.

Columna interna 3-plicata, plica superiori ampliori.

Habitat.—Prædium "*La Chorera*," municipium Viñales, in provincia Pinar del Rio.

Cylindrella colorata Arango (fig. 5).

Proc. Acad. Nat. Sciences, 1882, p. 106.

5.

A figure of this species is now given from a type specimen.

AUGUST 5.

Mr. EDW. POTTS in the chair.

Eleven persons present.

On Paludicella erecta.—Mr. EDWARD POTTS desired to have a preliminary record made of his recent discovery or identification of a new species of *Paludicella*, for which he proposes the name *Paludicella erecta.*

This genus of fresh-water polyps has heretofore contained only the single clearly defined species *P. Ehrenbergi*, Van Beneden (*Alcyonella articulata*, Ehrenberg), the other two names, *P. procumbens* and *P. elongata*, suggested by Mr. Albany Hancock and Prof. Leidy, being considered by Prof. Allman as identical with the original type. The present form is strikingly different from the old one, both in the number of its ciliated tentacles and in the character of the cœnœcial cells. The doubt which has lingered in the mind of the speaker has not been as to the species, but whether, in view of the difficult determination of the characteristic septæ between the cells, amounting in fact to an apparent absence of them, a new genus might not be required to accommodate it.

It was first noticed in Tacony Creek, a small stream in Montgomery County, Pennsylvania, at that place perhaps fifty feet above tide-water. A few days after it was also gathered within tidal limits in both the Delaware and Schuylkill Rivers, near Philadelphia. In the first-named locality it was found most abundantly in the pools amongst the rapids of the stream, frequently covering the upper surface of stones, at the depth of a foot or more, to the extent of many square inches. The erect portions of the cœnœcial cells in the denser parts of the colonies are about a line in height and, standing very closely, suggest a comparison with the surface of a chestnut-burr. In the rivers they were found penetrating the mass of encrusting sponges, particularly *Meyenia Leidyi.*

These upright tubules are chitinous prolongations of very irregularly inflated cells, resting in compact disorder upon the supporting surface, crossed and connected in some manner not yet intelligible, by meandering cylindrical rhizomes, sometimes of great relative length. These are mostly terminal and simple, but are sometimes branched and frequently originate in an indifferent lateral portion of a cell. The tubular prolongations are, of course, always single; the invaginated polyp retiring within the inflated portion of the cell. Septæ were, in a few instances, discovered in the rhizomes near their insertion or connection with the inflated portion of the cells. The upright

portions of those cells which seemed to be least matured were longer than those of their older neighbors, subclavate or spindle-shaped and rounded at the extremities. The others are cylindrical or slightly widening downwards and shorter than the former by the invagination of the terminal portion of the ectocyst. This has the effect of producing the angular appearance of the orifice, so familiar in the older species; but while that is generally quadrangular, this has frequently five or more sides. The younger cells are nearly transparent, but they darken with age and become somewhat encrusted with adherent particles and overgrown by commensal parasites, *Limnias*, *Pyxicola*, and the like.

The polypides are shy, but fond of the light, and when otherwise undisturbed will remain for a long time protruded in the full glare of microscopic illumination. It can then be seen that the lophophore is circular, without epistome, supporting ordinarily twenty tentacles, taking the shape of a claret glass and opening upwards. (Nineteen and twenty-one tentacles have been doubtfully counted, while the above-mentioned number is frequent; *P. Ehrenbergi* is universally stated to have but sixteen). A peculiarity of the tentacles is the presence upon the outer median line of each, of a rather sparsely filled series of quiescent setæ, in strong contrast with the rapidly moving cilia around them.

The development of this polyp from the ovum, of which interesting hints have been obtained, and its internal structural peculiarities, are reserved for further study, and if satisfactory results shall have been attained, they will be treated of in a later paper. The nearly simultaneous observation of this species in three distinct localities, and its abundance in each, indicates that it is probably not uncommon, and excites surprise that it does not appear to have been previously noticed.

August 12.

Mr. Thomas Meehan, Vice-President, in the chair.

Fifteen persons present.

A Large Zircon.—Dr. A. E. Foote recorded the discovery of the largest crystal of zircon ever known. It is 9½ inches high, 4 inches on one face and 3⅝ inches on the other. It undoubtedly originally weighed twelve pounds, but owing to a small portion being lost by fracturing it now weighs but eleven and three-quarter pounds. The largest crystal ever known before weighed less than three pounds. The crystal is doubly terminated, and, though somewhat broken in taking out nearly all the pieces were saved. At one end there are two terminations and one of these

was broken off in some great convulsion of the earth's surface. This had been separated from the main crystal by a piece of orthoclase that had unmistakably been formed since the rupture of the crystal. Such a fact is of great importance in studying the geological history of the formation. The locality is Brudinelle, Renfrew Co., Ontario, Canada, and the rock is a vein of pink feldspar in a Laurentian gneiss. It is associated with sphene and crystals of peristerite (?). Some of the faces of the latter show the moonstone reflections very plainly. Cavities once filled with calcite (now mostly dissolved away) occur in the vein. There are also some small crystals that need further examination.

AUGUST 19.

Mr. J. H. REDFIELD in the chair.

Fifteen persons present.

The death of W. L. Schaeffer, a member, was announced.

AUGUST 26.

Mr. J. H. REDFIELD in the chair.

Fourteen persons present.

The death of James L. Claghorn, a member, was announced.

Edward P. Bliss and Ralph W. Seiss, M.D., were elected members.

SEPTEMBER 2.

Rev. H. C. MCCOOK, D. D., Vice-President, in the chair.

Twenty-one persons present.

On the wide Distribution of some American Sponges.—Allusion having been made to the wide distribution of certain species of spiders over the North American continent, Mr. E. POTTS, referring to the fresh-water sponge fauna of this country, said, that *Spongilla fragilis*, the first species named in America, described by Dr. Leidy in 1851 from specimens collected near Philadelphia, had since been found abundantly along the Atlantic coast from Florida to Nova Scotia. It had been gathered at several points along the St. Lawrence and in the great lakes, through the middle continent, and in the far west had been described by Dr. Bowerbank, in 1863, under the name of *S. Lordii*, as found in the lakes and streams flowing from the Cascade Range in British Columbia,

affluents of the majestic Columbia River. The species may, therefore, be regarded as strictly continental in its range, and until very recently it has been distinctively American. It is a little singular that the only other place in which it has been noticed is in the neighborhood of Charkow, in Russia, where it was discovered, a few months since, by Dr. L. Dybowski.

The specimens of this species from Nova Scotia had been collected by Mr. A. H. Mackay, B. A., B. S., of Pictou Academy, Pictou, N. S., from whom the speaker had recently received a collection of sponges, phenomenal in its character, both as regards the number of genera and species represented, and the excellent judgment that had attached to most of them their proper names, from apparently very insufficient data. The collection was the result of few days' search within a limited district, "from lakes in and near the water shed of Nova Scotia, near the borders of the three counties of Pictou, Guysboro and Antigonish," at elevations of from 100 to 700 feet above sea level. Of the genus *Spongilla*, it contains three species, *S. lacustris*, *S. fragilis*, and *S. igloniformis;* of the genus *Meyenia*, two species, *M. fluviatilis* and *M. Everetti;* of the genus *Heteromeyenia*, two, *H. argyrosperma* and *H. Ryderi*, and of the genus *Tubella*, one species, *T. Pennsylvanica*—eight species, representing four genera. Besides these there were small specimens of another species, evidently new, but whose genus relations could not be determined on account of the absence of statoblasts.

In some respects the most important find in the collection is *Meyenia Everetti* Mills; this being only the second instance in which the species has been discovered. The original locality was Gilder Pond upon Mt. Everett, in Berkshire Co., Mass., at an elevation of 1800 or 2000 feet above the sea. It was there collected by Dr. F. Wolle and Mr. H. S. Kitchel of Bethlehem, Pa., well known for their invaluable work among the desmids and diatoms; and examined simultaneously by Mr. H. Mills of Buffalo, N. Y., and the speaker. Its most striking peculiarity is the presence, all through the dermal tissues, of very minute birotulate spicules, the only instance in which these have been observed as characteristic features of the dermal surface in any fresh-water sponges; unless the complicated forms found in *Meyenia plumosa* Carter, may be considered an exception.

These birotulates in the present collection average one-third longer than those before examined, and are in every way more robust. The speaker was gratified in finding this confirmation of a rule which he has long since observed to hold amongst the infinite variations of size and form noticeable in collections of the same species from various localities; viz., that the spicules of all species increase regularly in size and solidity as we descend from high altitudes towards the sea-level, where is found the extreme limit of the series. He does not attribute this gradation to a change conditions, but more probably to a gradual and con-

stant improvement in the food-supply or in the siliceous constituent of the water. He has traced the workings of the rule more particularly through the very variable species, *Spongilla lacustris* and *S. fragilis*: in *Meyenia fluviatilis*, in *Heteromeyenia argyrosperma* and *H. Ryderi*, and lastly and most conspicuously in *Tubella Pennsylvanica*. The extremes in this last series differ so widely that they would hardly be taken to belong to the same species, but the intermediate grades have all been collected, largely from the same stream; and as a result several species named in this and other cases, have relapsed into synonyms.

SEPTEMBER 9.

Dr. W. S. W. RUSCHENBERGER, in the chair.

Eleven persons present.

The death of R. E. Rogers, M. D., a member, was announced.

SEPTEMBER 16.

Rev. H. C. MCCOOK, D. D., Vice-President, in the chair.

Seventeen persons present.

On the Minute Fauna of Fairmount Reservoir.—Mr. E. POTTS alluded to the difficulties that ordinarily prevent a thorough study of the fixed aquatic fauna, which he described as thereby generally limited to collections from the shallow water near the margins of lakes and streams, or of such forms as may adhere to the few timbers or stones that can be dragged from a greater depth. He therefore urged the importance of making use of such opportunities as are furnished by the temporary drainage of reservoirs, canals, etc., to examine thoroughly the incrustations upon exposed walls and timbers, or on the bed of the stream.

Such an occasion was afforded a few days since, when the accidental breaking of a valve necessitated the drawing off of the water from the Fairmount reservoirs. These are divided by perpendicular walls, eight or ten feet in height, and, unfortunately, facilities were not at hand in the shape of ladders, planks, etc., to enable him to make a minute examination of them. From the margin, however, could be seen at many places patches of the sponges, *Spongilla fragilis* and *Meyenia fluviatilis*, while the cages over the outlet pipes, and, more strikingly, the walls surrounding the main outlet at the southeast corner, were thickly encrusted with *Meyenia Leidyi*. The last-named sponge is very compact and little liable to crumble during the winter season, so that it is probable that the large masses, some of them nearly an inch in thick-

ness, and a foot or two in diameter, represent the aggregation of several years. In a few places, at the base of the walls, the pale green branches of *Spongilla lacustris* could be seen, and occasionally, to the speaker's surprise, slender waving processes of the same species, totally colorless, could be seen reaching up through the mud in little groups upon the bottom. He was surprised, because he had always held that it was impossible for sponges to live upon a muddy bottom, and theoretic reasoning would still suggest that probably only this species, which can thus hold itself up out of the suffocating silt, can survive the constant deposition of siliceous particles. The total amount of sponge growth was relatively small, and the probability of an aqueous taint from it, very remote.

The commensal habit of many of the lower animals who feed by the creation of ciliary whirlpool currents, has been frequently referred to; the weaker current-makers, such as vorticellæ, stentors, and the errant and tubicolous rotifers, planting themselves about the heads of the stronger polyzoa to supply their own nets with what may have escaped from the others. The same instinctive principle which leads all these to locate themselves most plentifully amongst the stones in the rapids of streams, was particularly noticeable in promoting their aggregation upon and in the neighborhood of the inlet and outlet gates of the reservoirs. The feeble currents produced by each can only bring within its reach the floating provision from a very limited area; the volume of water poured through these gates brings to them a rich supply, and the numbers and variety of these organisms increase in proportion. Of the fixed forms were seen amongst the bryozoa, beside one or more undetermined species of *Plumatella*—*Pectinatella magnifica* and *Urnatella gracilis* of Leidy, and the newly described *Paludicella erecta*. Attached to these were Vorticellæ, Epistilis and Stentors innumerable; *Pyxicola* and *Acineta;* rotifers of various names, including prominently *Limnias* and other, probably undescribed forms among the Melicertidæ. Very abundant among these was the interesting chætobranch annelid, *Manayunkia speciosa* Leidy, which has of late been frequently noticed in this vicinity, and the wonderfully marine-looking hydroid *Cordylophora lacustris*. This last was particularly abundant around the southeast outlet; its stems forming a complete matting over many yards of surface, commingled with bryozoa and sponges in intricate confusion.

A large valve had been removed from a discharging main on the southern side of the reservoir hill, a hundred yards or more from the opening in the bottom of one of the basins, and where all light was consequently absent. An incrustation, averaging perhaps three-eighths of an inch in thickness, upon the inner surface of this valve, was found to be largely composed of the gemmulæ and spicules of *Meyenia Leidyi;* mingled with which were stems of

Plumatella, *Urnatella*, and *Cordylophora lacustris*. The fact that all these can thus thrive in absolute darkness throws some doubt upon the supposed sensitiveness of these forms to the presence or absence of light, as does also the fact that while *Paludicella Ehrenbergi* is said to seek the darkest corners, the speaker found his new species, *P. erecta*, apparently rejoicing in the glare of the full sunlight.

Of course many other creatures than those above named were casually seen in this connection, including chiefly amœbæ, free-swimming protozoans and entomostracans, planarian worms, hydras and aquatic insect-larvæ; but the former are particularly mentioned as among the most interesting and beautiful of those that freely and innocently drink of the same cup with ourselves.

SEPTEMBER 23.

Mr. EDW. POTTS, in the chair.

Nine persons present.

The following papers were presented for publication:—

"A Review of the American Species of the Genus Hemiramphus," by Seth E. Meek and David K. Goss.

"A Review of the American Species of the Genus Teuthis," by Seth E. Meek and Martin L. Hoffman.

"A Review of the American Species of Scomberomorus," by Seth E. Meek and Robert G. Newland.

Tunisian Flints.—Dr. D. G. BRINTON remarked that the flints presented through him this evening had been received from the eminent archæologist, the Marquis de Nadaillac, whose son, an officer in the French army, obtained them at the station of Ras-el-Oued, near Biban, on the southeastern coast of Tunis. The specimens consist of flint chips, arrow-points, and a semi-lunar shaped implement of small size, which resembles the "stemmed scrapers" found in America. This form was obtained from the lower levels, and is characteristic, in France, of the later productions of the stone age, especially of that epoch called by French archæologists "the epoch of Robenhausen," from the locality of that name in Switzerland. Chronologically, this is the first epoch of the appearance of man on the globe, the previous implement-using animals being more properly anthropoids. Those made use of stone only, not having learned the dressing of bone or horn. This view adds to the interest of the query as to the purpose of these scrapers, as they are called in default of a better name. That they were an important tool to the primitive man is evident from their wide distribution. They have been found in

France, in the Crimea, in India, in America, in strata of great antiquity (both North and South America), and here we have them in Africa.

The archæology of the North African Coast has special claims to attention, as from there apparently a very ancient migration advanced northward, passing in one direction through Spain, and in another by way of Malta, Sicily and Italy. This was cotemporary with the appearance of the *Elephas Africanus* in Europe, whose bones have been found in intimate association with those of man in various localities. It was long anterior to the immigration of the Iberians or Basques, who by some are traced to North Africa. Another point of interest may be added. The only locality in the Old World where animal or effigy mounds have been reported is in North Africa, in Algiers, near the forest of Tenrit-el-Sad, south of Miliana. As these peculiar structures are so frequent in the Mississippi Valley, the coincidence is worth noting.

Prof. HEILPRIN contended, that while on the hypothesis of evolution no objection could be raised to an assumption which made an animal intermediate between man and the anthropoid apes sufficiently intelligent to understand the full value and manufacture of stone implements such as were exhibited, yet, as a matter of fact, paleontological evidence had thus far failed to prove that any such use or manufacture had been made of them, as was here claimed. Indeed, no evidence was forthcoming to show that the implements were not the work of man himself, despite the fact that no traces of human remains were found associated with the fragments. The assumption that the advent of man dates only to a given period of the so-called "stone age," was considered to be purely gratuitous, and to rest solely on negative evidence. Many archæologists concur in the belief that his remains may yet be found in deposits of strictly Tertiary age, and some, even in the early part of this period. The speaker discussed the theory of the migration of races, and the successive introduction, into different regions, at different periods of time, of the various epochs marking the development of the human race.

SEPTEMBER 30.

Mr. EDW. POTTS in the chair.

Twenty-four persons present.

Henry F. Osborn, John Wanamaker, and Miss Adele M. Fielde were elected members.

The following were ordered to be printed:—

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS HEMIRHAMPHUS.

BY SETH E. MEEK AND DAVID K. GOSS.

The American species of the genus *Hemirhamphus* are in a condition of great confusion. In this paper we have endeavored to give the synonyms of those species which seem to be valid, with an analysis of their specific characters. The paper is based on specimens belonging to the Indiana University, and to the United States National Museum, all of them collected by Professor David S. Jordan on the coast of Florida and at Havana.

This collection comprises three of the four Atlantic species admitted by us, the published descriptions indicating the existence of another (*H. balao*), as yet unknown to us.

Euleptorhamphus longirostris is not here mentioned, as we regard it as the type of a genus distinct from *Hemirhamphus*.

We are very much indebted to Professor Jordan for use of his library and for valuable aid.

Analysis of American species of the genus Hemirhamphus.

a. Anal fin about as long as dorsal and opposite it, its rays 14 to 16; sides with a distinct silvery band; last ray of dorsal not produced in a filament.

b. Ventrals inserted about midway between base of caudal and posterior margin of eye; dorsal and anal fins scaly; lat. l. 53 to 56.

c. Length of mandible (from tip of upper jaw) not longer than rest of head; body and head comparatively robust; D. 15; A. 16. *unifasciatus.* 1.

cc. Length of mandible (from tip of upper jaw) not shorter than rest of head; body comparatively slender. D. 14; A. 15. *roberti.* 2.

bb. Ventrals inserted midway between base of caudal and gill openings; dorsal and anal fins not scaly; lat. l. 63; D. 14; A. 14. *rosæ.* 3.

aa. Anal fin about $\frac{3}{8}$ length of dorsal, its insertion behind that of dorsal, its rays 11 or 12; sides without distinct silvery band; last ray of dorsal produced in a short filament.

d. Scales comparatively large, about 53 in lateral line; upper lobe of caudal bright orange in life. D. 14; A. 12. *pleii*. 4.

dd. Scales comparatively small, about 63 in lateral line (*Valenciennes*); upper lobe of caudal dirty violet (*Poey*); D. 11–14; A. 11–12 (*Poey*). *balao*. 5.

1. **Hemirhamphus unifasciatus.**

Hemirhamphus unifasciatus Ranzani, Nov. Comm. Acad. Sci. Inst., Bonon, v, 1842, 326, Taf. 25 (Brazil); Günther, Cat. Fish. Brit. Mus., vi, 1866, 262 (in part; West Indies; Rio Janeiro); Cope, Trans. Amer. Phil. Soc., 1871, 481 (St. Martin's); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 924 (Panama; no description). (Not *H. unifasciatus* of most American writers.)

? *Hemirhamphus picarti* Cuv. & Val., Hist. Nat. Poiss., xix, 1846, 25 (Africa).

Hemirhamphus richardi Cuvier & Valenciennes, Hist. Nat. Poiss., xix, 1846, 26 (Antilles; Cayenne; Bahia; Rio Janeiro).

Hyporhamphus tricuspidatus Gill, Proc. Acad. Nat. Sci. Phila., 1859, 131 (Barbadoes).

Hemirhamphus fasciatus Poey, Memorias, ii, 1860, 299 (Cuba; not of Bleeker).

Hemirhamphus poeyi Günther, Cat. Fish. Brit. Mus., vi, 1866, 262 (on *H. fasciatus* Poey); Poey, Syn. Pisc. Cub., 1868, 383 (Cuba); Poey, Enumeration Pisc. Cub., 1875, 121 (Cuba); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 273, 381 (Panama).

Habitat.—Both coasts of tropical America and West Indies; Panama; Cuba; West Indies; Antilles; St. Martin's; Rio Janeiro; Cayenne; Bahia.

This species is known to us from many specimens collected by Professor Jordan at Havana and Key West. Young examples are more slender than the old ones, and have the lower jaw proportionately shorter. Both young and old are, however, more robust, shorter and thicker in every part than specimens of *H. roberti* of the same size. Except this difference of form, we are unable to detect any distinction whatever. We have no doubt, however, that the two are really different.

The figure and description of Ranzani represents this species much better than *H. roberti.* We therefore retain for it his original name. *H. richardi* Cuvier & Valenciennes is evidently the same, and *H. picarti* is at least very similar. Gill's *Hyporhamphus tricuspidatus* is not very satisfactorily described, but as its author afterwards refers to it as probably identical with *H. richardi*, and as the description and locality best fit that species, we have so considered it.

Our Havana specimens leave no doubt that *H. fasciatus* and its synonym, *H. poeyi*, are based on this species. Its lower jaw is, however, longer than Poey describes, and but for this Dr. Günther would evidently have referred Poey's description to *H. unifasciatus.* Specimens collected by Captain Dow, at Havana, show that this is one of the species found on both sides of the isthmus.

2. Hemirhamphus roberti.

Hemirhamphus roberti Cuvier & Valenciennes, Hist. Nat. Poiss., xix, 1846, 24 (Cayenne); Günther, Cat. Fish. Brit. Mus., vi, 1866, 263 (New Orleans).

Hemirhamphus unifasciatus Cope, Proc. Acad. Nat. Sci. Phila., 1870, 119 (Newport, R. I.; Jordan and Gilbert, Proc. U. S. Nat. Mus., 1878, 383 (Beaufort, N. C.), no description; Goode, Proc. U. S. Nat. Mus., 1879, 116 (Name only); Jordan, Proc. U. S. Nat. Mus., 1880, 20 (San Sebastian River, Fla.); Jordan, Proc. U. S. Nat. Mus., 1880, 22 (St. John's River, Fla.), no description; Jordan and Gilbert, Proc. U. S. Nat. Mus., 1881, 274 (Guaymas); Jordan and Gilbert, Bull. U. S. Fish Comm., 1882, 106 (Mazatlan); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 588 (Charleston, S. C.); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 356 (Cape San Lucas); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 262 (Pensacola, Fla.); Goode and Bean, Proc. U. S. Nat. Mus., 1882, 239 (Gulf of Mexico), no description; Jordan and Gilbert, Syn. Fish. N. A., 1882, 376.

Habitat.—Both coasts of America, chiefly north of the tropics: Beaufort; Charleston; Pensacola, San Sebastian River; Cedar Keys; New Orleans; Cayenne; Mazatlan; Guaymas; Cape San Lucas.

All the specimens of *Hemirhamphus* thus far taken on the Atlantic Coast of the United States, north of the Florida Keys (except one of *H. pleii*), belong to a species differing from the West Indian *unifasciatus*, in the slenderness of body and in the greater length of the lower jaw. This is evidently the *H. roberti*

of Günther and the *H. unifasciatus* of all the American local lists. The *H. roberti* of Cuvier and Valenciennes is very scantily described. It is, however, related to *H. unifasciatus*, and is said to have the lower jaw longer than in *H. richardi* or *H. picarti*. We therefore identify it with this species, with this element of doubt, that there is no other record of the slender form south of Central Florida. This species occurs also in the Gulf of California. Specimens from Charleston and from Mazatlan are described by Jordan and Gilbert, as having the anterior rays of dorsal and anal, and the upper and lower rays of caudal jet-black, but no other difference from the usual form was noted.

3. **Hemirhamphus rosæ.**

Hemirhamphus, sp. incert., Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 29 (San Diego).

Hemirhamphus rosæ Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 335 (San Diego, Cal.); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1880, 457 (San Pedro, San Diego); Jordan and Jouy, Proc. U. S. Nat. Mus., 1881, 13 (San Diego); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1881, 43 (San Diego); Bean, Proc. U. S. Nat. Mus., 1881, 316 (name only); Jordan and Gilbert, Syn. Fish. N. A., 1882, 376.

Habitat.—Pacific Coast of United States; San Diego; San Pedro.

We have nothing to add to the account of this species.

4. **Hemirhamphus pleii.**

Hemirhamphus marginatus Le Sueur, Jour. Acad. Nat. Sci. Phila., ii, 1823, 135 (Lesser Antilles; not of Forskål).

Hemirhamphus pleii Cuvier & Valenciennes, Hist. Nat. Poiss., xix, 1846, 29 (Antilles; Martinique; San Domingo); Günther, Cat. Fish. Brit. Mus., vi, 1866, 269 (Jamaica; Dominica; Bahia; West Indies); Bean, Proc. U. S. Nat. Mus., 1880, 103 (Bermudas).

Hemirhamphus filamentosus Poey, Syn. Pisc. Cub., 1868, 382 (Cuba); Poey, Enum. Pisc. Cub., 1875, 121 (Cuba).

Hemirhamphus brasiliensis Jordan & Gilbert, Syn. Fish. N. A., 1882, 902 (Hunger's Wharf, Virginia; not of Günther).

Habitat.—Atlantic Coasts of America and West Indies, Virginia to Brazil. Virginia; Martinique; San Domingo; Jamaica; Dominica; Bermudas; Bahia.

This species is very abundant at Key West, where it is known as *Balao*, and at Havana, where it is called *Escribano*. It occa-

sionally ranges northward, a specimen from Virginia being in the National Museum. This is evidently *Hemirhamphus filamentosus* of Poey. The scanty description of *H. pleii* of Cuvier and Valenciennes seems to refer to it, at least in large part, as this is the only species so far as known that has the upper lobe of the caudal red or yellow in life. This is also the *H. marginatus* of Le Sueur, but not the original *H. marginatus* of Forskal.

5. **Hemirhamphus balao.**

? *Esox maxilla inferiore producta* Brown, Jamaica, 1756, 443, t. 45, f. 2 (Jamaica).

Esox brasiliensis Linnæus, Syst. Nat., ed. 10, 1758, 314 (in part; reference to Brown; not *Timucu* Marcgrave, which should be regarded as the Linnæan type, as having given rise to the name *brasiliensis*).

Hemirhamphus brasiliensis Günther, Cat. Fish. Brit. Mus., vi, 1866, 270 (based on *Hemirhamphus browni* Cuv. and Val.); ? Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 109 (Panama; name only); ? Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 624 (Panama).

Hemirhamphus balao Le Sueur, Jour. Acad. Nat. Sci., Phila., ii, 1823. 135 (Lesser Antilles).

Hemirhamphus browni Cuvier & Valenciennes, Hist. Nat. Poiss., xix, 1846, 13 (Guadaloupe; Martinique).

Hemirhamphus macrochirus Poey, Memorias, ii, 1858, 299 (Cuba); Poey, Enum. Pisc. Cub., 1875, 121 (Cuba).

Habitat. — Coasts of tropical America and West Indies; Jamaica; Lesser Antilles; Guadaloupe; Martinique; Cuba; Panama.

We have not seen this species and are not entirely certain of its distinction from *H. pleii.* In *Hemirhamphus pleii* the upper lobe of the caudal is always bright orange-red and the number of scales in a longitudinal series is about 56. The description of *H. balao*, *H. browni* and *H. macrochirus* all refer to a fish with smaller scales, with both lobes of the caudal bluish, and *H. browni* and *H. macrochirus* have smaller scales than *H. pleii.* The specimens obtained by Professor Gilbert at Mazatlan, Panama, we refer provisionally to this species, but they may prove different on actual comparison. The oldest tenable name for this species seems to be *H. balao* Le Sueur.

Esox brasiliensis Linnæus is based on Brown's description of a *Hemirhamphus* from Jamaica, and Marcgrave's account of a

Tylosurus from Brazil. The name *brasiliensis* is evidently suggested by the latter, which should therefore retain it as specific name. It does not appear also certain as to which species of *Hemirhamphus* is described by Brown.

TABLE OF MEASUREMENTS.

(In hundredths of length to base of caudal.)

	H. unifasciatus.					*H. roberti.*				*H. rosæ.*	*H. pietii.*				
LOCALITIES.	Key West.	Key West.	Key West.	Key West.	Key West.	Cedar Keys.	Cedar Keys.	Cedar Keys.	Cedar Keys.	San Diego.	Key West.	Key West.	Key West.	Key West.	Key West.
Length of specimen, in inches.	7·45	6·05	7·50	6·45	5·2	5·75	6·1	5·85	6·2	4	5·6	6·4	10·3	11·2	8·85
Head, from tip of upper jaw to gill opening (Hundredths)	21½	21½	22	23	22½	22½	23	23	23¼	20	18½	18½	19½	18½	19
Head, from tip of lower jaw to gill openings	42½	40½	42	43	43½	47	47½	47½	48½	50	43	44¼	41½	42	41½
Distance of ventrals from tip of snout	57	59	57	59	57	57	60	58	59	65	53½	54	54¼	52	52½
Distance of dorsal from tip of snout	78	76	77½	78	78	77	79	78	79	76	61½	62	60½	59	60
Length of pectorals	13	13¾	14	14	14	14	14	14	14½	11½	14	14	13½	14	14
Depth of fish at ventrals	14	14½	14	13½	14	13	13	12	13	11½	[illegible]	11½	12¼	13½	12½
Thickness of fish at ventrals	10	11	10½	9	9½	8½	8¼	8½	8½	8	6	6	6	6	6
Least depth of caudal peduncle	5½	6	6	5	6	5	5	5	5	4½					
Length of base of dorsal	14½	14	14	14	14	14	14	13½	14½	16	11	12	12	11	12
Diameter of eye	5¼	5½	5½	5½	5½	5	5¼	5	5½	5	4½	4¼	[illegible]	4½	4½
Width of interorbital	6	6	6	6	6	5½	5½	5½	6	6	4½	4½	5	4½	4½
Breadth of head at posterior end of maxillary	6½	5¾	6½	5½	6¼	4½	5	6	5½						
Breadth of beak at tip of upper jaw	3½	3¾	3½	3½	3½	3	3	3	3¼						

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS TEUTHIS.

BY SETH E. MEEK AND MARTIN L. HOFFMAN.

In the present paper is given the synonymy of the American species of *Teuthis* L. (= *Acanthurus* Forskål) with an analysis of their most important specific characters.

Specimens of each of three species, which seem to us valid, were obtained by Professor David S. Jordan, at Havana and at Key West. On this material, belonging to the Indiana University and the United States National Museum, the present paper is based. It is possible that other species exist in American waters, but there is certainly nothing in any published description which suggests the probability that such is the case.

We are indebted to Professor Jordan for use of his library and for valuable aid.

Analysis of American Species of Teuthis.

a. Outline rhomboid, the depth $1\frac{1}{2}$ in length to base of caudal; anterior profile subvertical, nearly straight, making an angle of about 60° with axis of body; color brown, washed with bright blue; body marked with undulating longitudinal light streaks; no dark crossbars; vertical fins with oblique bronze streaks; lips and caudal spine yellow; caudal deeply emarginate, its lobes about equal in length; middle rays about $\frac{3}{4}$ length of outer rays; head $3\frac{1}{4}$ in length to base of caudal. D. IX–27; A. III–24. *cœruleus.* 1

aa. Outline ovate; the depth 2 in length to base of caudal; anterior profile moderately convex, making angle of about 45° with axis of body.

b. Caudal deeply emarginate, its upper lobe longer than lower, slender and produced into a filament, the inner rays $\frac{3}{5}$ length of the outer rays (in the adult); margin of caudal fin whitish; color dark brown, no transverse bars; brown wavy longitudinal streaks on sides of body; eight dark lines running parallel with edge of dorsal fin for its whole length, and separated by interspaces of the same width; anal fin bluish, with a violet base; head $3\frac{1}{2}$ in length of body. D. IX–24; A. III–22. *tractus.* 2

bb. Caudal simply lunate, its inner rays about ⅔ length outer rays; caudal lobes subequal, the upper never filamentous; color olive-brown, more or less distinctly greenish; middle of sides paler; sides with about twelve distinct blackish vertical bars, rather narrower than the interspaces, most distinct over front of anal; a brownish stripe along base of dorsal; spinous dorsal with alternate stripes running upward and backward, of dark blue and bronze olive, the two colors of about equal width; soft dorsal with a bluish streak on the anterior side of each ray, and a bronze stripe behind it; head 3½ in length of body. D. IX–26; A. III–24. *hepatus*. 3.

1. **Teuthis cœruleus.**

Turdus rhomboidalis (The *Tang*), Catesby, Nat. Hist. Carolina, etc., ii, 1743, pl. 10, fig. 1 (Bahamas).

Teuthis fusca cæruleo nitens Brown, Jamaica, 1756, 454 (Jamaica).

Barbero Parra, Descr. Dif. Piezas, Hist. Nat., 1787, 45, Taf. 21, fig. 2 (Cuba).

Acanthurus cæruleus Bloch & Schneider, Systema Ichthyol., 1801, 214 (after Catesby, Parra & Brown); Cuvier & Valenciennes, Hist. Nat. Poiss., x, 1835, 179 (Martinique; Porto Rico; San Domingo); Günther, Cat. Fish. Brit. Mus., 1861, 336 (Caribbean Sea; West Indies; Bahia); Poey, Syn. Pisc. Cub., 1868, 355 (Cuba); Jordan & Gilbert, Syn. Fish. N. A., 1882, 617.

Acanthurus broussonnetii Desmarest, Prem. Dec. Ichthyol., 1823, 26, pl. 4, fig. 2 (Cuba).

Acanthurus brevis Poey, Memorias, ii, 1860, 207 (Cuba; young); Poey, Syn. Pisc. Cub., 1868, 355 (Cuba); Poey, Enum. Pisc. Cub., 1875, 66 (Cuba).

Acronurus cæruleatus Poey, Enum. Pisc. Cub., 1875, 69 (Cuba; larval form).

Acanthurus nigricans Goode, Bull. U. S. Nat. Mus., 1876, 41 (Bermudas) (probably not of Linnæus, a species of unknown origin, as yet unrecognized).

Habitat.—Atlantic shores of tropical America; Cuba; Key West; Martinique; Porto Rico; San Domingo; Bahia.

The synonymy and nomenclature of this beautiful species seem to be subject to no doubts of importance. It is rather less abundant at Key West or at Havana than either of the other species. One specimen corresponding to *A. brevis* Poey,

was taken at Key West. This is precisely like the adult, but shows very little blue.

The species called *Acronurus* are, as shown by Günther and Lütken, the young of *Teuthis*. The three species mentioned by Poey (*cœruleatus*, *nigriculus*, *carneus*) seem to be the young respectively of three species of *Acanthurus*. One of these, *Acronurus carneus*, was obtained by Prof. Jordan; we regard it as unquestionably the young of *Teuthis hepatus*.

2. **Teuthis tractus.**

Acanthurus tractus Poey, Memorias, ii, 1860, 208 (Cuba); Poey, Rept., 1866, 356 (Cuba); Poey, Syn. Pisc. Cub., 1868, 356 (Cuba); Poey, Anales Soc. Hist. Nat. Madrid, 1880, 246 (Cuba); Poey, Enum. Pisc. Cub., 1875, 67 (Cuba); Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 108 (Mazatlan: no description); Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 111 (Panama; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 377 (Panama; no description); Jordan & Gilbert, Syn. Fish. N. A., 1882, 941.

Acronurus nigriculus Poey, Enum. Pisc. Cub., 1875, 69 (Cuba; larval form).

Acanthurus matoides Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 626 (Panama; no description; not of Cuvier & Valenciennes).

Habitat.—Coasts of tropical America; Cuba; Panama. Key West; Mazatlan; Panama.

This species may at all ages be known by the form of its caudal. Although in all species the caudal lobes grow longer with age, still very young specimens, as well as old of this species have the caudal more deeply furcate than any of *T. hepatus*.

There are also some color differences between the two.

The single species of *Teuthis* found on the Pacific coast of tropical America seems to be identical with *T. tractus*. It is close to *A. matoides* Cuvier & Valenciennes, but Prof. Jordan, who has examined the type of the latter in Paris, thinks it different.

3. **Teuthis hepatus.**

Hepatus mucrone reflexo utrinque prope caudam Gronow, Zoophyl, No. 353.

Teuthis hepatus Linnæus, Syst. Nat., ed. 12, 1766, 507 (not as restricted by Cuvier & Valenciennes; is based principally on *Hepatus* of Gronow).

Acanthurus hepatus Bloch & Schneider, Systema Ichthyol., 1801, 211 (in part; not of Cuv. & Val. and later authors).

Chæodon chirurgus Bloch, Ausl. Fish., 1784, 99, sp. n. 24, taf. 208 (on a drawing by Plumier); Gmelin, Syst. Nat., 1789, 1259 (copied).

Acanthurus chirurgus Bloch & Schneider, Systema Ichth., 1801, 214 (copied); Cuvier & Valenciennes, Hist. Nat. Poiss., x, 1835, 168, (Martinique; Brazil; Cuba); Günther, Cat. Fish. Brit. Mus., iii, 1861, 329 (Bahia; Puerto Cabello; Caribbean Sea; West Indies); Poey, Syn. Pisc. Cub., 1868, 355 (Cuba); Goode, Bull. U. S. Nat. Mus., 1876, 42 (Bermudas); Poey, Anal. Soc. Nat. Hist., Madrid, 1880, 245, pl. 6 (Cuba); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237 (name only); Jordan & Gilbert, Syn. Fish. N. A., 1882, 617.

Acanthurus phlebotomus Cuvier & Valenciennes, Hist. Nat. Poiss., x, 1835, 176 (Martinique; Brazil; Havana; New York); Dekay, New York Fauna Fish, 1842, 139, pl. 73, fig. 234 (copied); Poey, Repertorio, 1867, i, 256 (Cuba); Poey, Syn. Pisc. Cub., 1868, 245, fig. 7 (Cuba); Poey, Soc. Hist. Madrid, 1880, 245 (Cuba).

Acronurus fuscus Gronow, Cat. Fish., ed. Gray, 1858, 191.

Acanthurus nigricans Jordan & Gilbert, Syn. Fish. N. A., 1882, 941 (copied).

Habitat.—Atlantic Coast of America. Key West; Cuba; West Indies; Puerto Cabello; Martinique; Caribbean Sea; Brazil; Bahia.

This is the most abundant species of the genus, being apparently common throughout the West Indies, and certainly so at Cuba and Key West, and ranging northward occasionally on our South Atlantic Coast, perhaps as far as Charleston, but certainly not to New York, where it is reported on the authority of the confused collection of Milbert.

Two questions arise in the synonymy of this species; first, as to the identity of *phlebotomus* with *chirurgus*; second, as to the availability of the Linnæan name *hepatus* and *nigricans* for it. As to the first point, the description and figure of Cuvier and Valenciennes agree too well with our specimens for us to doubt their identity. Poey recognizes a species, *A. phlebotomus*, as distinct from *A. chirurgus* Poey, but on characters of slight importance and variable with age. The Linnæan name *nigricans* has been used both for this species and for *T. cæruleus*. The name is based on a description of Artedi, which has been considered by Cuvier and Valenciennes as probably belonging to an Asiatic species. The locality of the original specimen is uncertain, and the species cannot be positively made out. No American species should therefore be called *nigricans*.

The name *hepatus* has been used by Cuvier and Valenciennes

for an Asiatic species. The original *Teuthis hepatus* of Linnæus is based on various references, including *cæruleus*, *chirurgus* and the Asiatic species in question. The original type is, however, evidently the *Hepatus mucrone reflexo utrinque prope caudam* of Gronow, and part of the confusion has come from Gronow's attempt to identify with his specimen the Asiatic references of Valentyn and others. Gronow's specimen, however, is the type of his *Hepatus*, and consequently the proper type of *Teuthis hepatus* Linnæus. This same specimen, *Hepatus*, became the *Acronurus fuscus* of Gronow's Systema (Gray), and it is still in the British Museum. Günther identifies it with *Acanthurus chirurgus;* we do not, therefore, see how the substitution of *hepatus* for *chirurgus* is to be avoided, if the rules of nomenclature are strictly carried out. The same line of argument is used by Cuvier and Valenciennes, but they erroneously supposed Gronow's specimen to be an Asiatic fish.

Poey has referred the *Chætodon chirurgus* of Cuvier and Valenciennes to *Acanthurus tractus*, because of this expression in their description: "La caudale échancrée en croissant jusqu'au tiers peu près de sa longueur; ses lobes sont arguisés en pointe et le supérieur est plus long que l'inférieur." This does not indicate the *tractus*, which has the caudal still more deeply divided, and it is true of the average example of *T. hepatus*. *Acronurus carneus* seems to be the young of this species.

A REVIEW OF THE AMERICAN SPECIES OF SCOMBEROMORUS.

BY SETH E. MEEK AND ROBERT G. NEWLAND.

In the present paper we have given the synonymy of the four American species of the genus *Scomberomorus* Lacépède (= *Cybium* Cuvier), and an analytical key, by which the species may be distinguished.

The specimens upon which the paper is based, belong to the Museum of the Indiana University. They have been collected by Professor Jordan at Key West, Havana, and Monterey.

We acknowledge our indebtedness to Professor Jordan for the use of his library and for valuable aid.

Analysis of the American Species of Scomberomorus.

a. Dorsal spines 17 or 18; lateral line descending obliquely; gill rakers comparatively long, more than half diameter of eye.

b. Teeth slender, subconical, their length more than twice their width at base; gill rakers long and slender, about $\frac{3}{5}$ diameter of eye, about 18 below the angle; maxillary reaching to opposite posterior margin of eye. Color of male dark steel-blue, without streaks or spots; female with two rows of alternating round bronze spots of about the size of pupil; fins nearly plain, dark; head $5\frac{1}{4}$ in length; depth $5\frac{3}{4}$. D. XVII–16–VIII; A. I–16–VIII. *concolor*. 1.

bb. Teeth large, triangular, compressed, their length not twice their breadth at base; gill rakers rather slender, their length about $\frac{3}{5}$ diameter of eye; about 12 below the angle.

c. Color bluish silvery above, with bright reflections; sides in both sexes, with numerous bronze spots about as large as pupil, no longitudinal stripes; maxillary reaching to opposite posterior part of orbit; angle of preopercle not produced backwards; pectoral scaly at base only; caudal peduncle rather robust, its least depth $4\frac{2}{3}$ in head, caudal widely forked; head $4\frac{3}{4}$ in length; depth $5\frac{1}{2}$. D. XVIII–18–IX; A. II–17–VIII. *maculatus*. 2.

cc. Color silvery; sides with a brownish, broken, longitudinal band, above and below which are numerous brownish spots; angle of preopercle produced backwards; pectorals scaly; anterior part of spinous dorsal black; caudal peduncle rather slender, its least depth 5½ in head; caudal less widely forked; head 4½ in length; depth 5½. D. XVIII–15–VIII; A. II–15–VIII. *regalis.* 3

aa. Dorsal spines 14 or 15, lateral line descending abruptly under second dorsal; teeth comparatively large; gill rakers very short, less than ½ diameter of eye, about 8 below the angle; pectorals scaly at base only; young, with bronze spots; adult immaculate. *cavalla.* 4.

1. **Scomberomorus concolor.** Monterey Mackerel.

Chriomitra concolor Lockington, Proc. Acad. Nat. Sci. Phila., 1879, 134 (Monterey); Lockington, Rep. Cal. Fish Comm. (1878–9), 1881, 34 (Monterey).

Scomberomorus concolor Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 456 (Monterey, no description); Jordan and Jouy, Proc. U. S. Nat. Mus., 4, 1881, 13 (Soquel, Cal., no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1881, 45 (Monterey Bay); Jordan and Gilbert, Syn. Fish. N. A., 1882, 426.

Habitat.—Pacific Coast of United States; Monterey Bay, all the known specimens having been taken about Soquel and Santa Cruz, whither it resorts every summer for a short time, for the purpose of spawning. Some 15 to 40 specimens only are taken each year.

2. **Scomberomorus maculatus.** Spanish Mackerel.

Scomber maculatus Mitchill, Trans. Lit. and Phil. Soc., i, 1815, 426, pl. 6, f. 8 (New York).

Cybium maculatum Cuvier, Règ. Anim., ed. 2, 1829 (after Mitchill); Agassiz, Spix. Pisc. Brazil, 1829, p. 103, tab. 60 (Atlantic); Cuvier and Valenciennes, Hist. Nat. Poiss., viii, 1831, 181 (New York); Storer, Bost. Jour., iv, 1842, 179 (Lynn, Mass.); Ayres, Bost. Jour. Nat. Hist., iv, 1842, 261 (Brookhaven); De Kay, N. Y. Fauna, Fish, 1842, 108, pl. 73, f. 232 (Long Island); Storer, Synopsis, 1846, 92: Baird, Fish N. J. Coast, 1855, 21 (Peaseley's Point); Günther, Cat. Fish. Brit. Mus., ii, 1860, 372; Storer, Hist. Fish. Mass., 1867, 68. pl. 13, f. 1 (Lynn, Mass.; Provincetown): Gill, Rept. U. S. Fish Comm., 1871–72, 802 (name only); Baird, Rept. U. S. Fish Comm., 1871–72, 825 (Wood's Holl), no description; Gill, Cat. Fish. E.

Coast N. A., 1873, 24 (name only); Poey, Proc. U. S. Nat. Mus., 1878, 4 (after Cuvier and Valenciennes); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1878, 375 (Albemarle Sound); Goode, Proc. U. S. Nat. Mus., 1879, 3 (East, Florida), no description; Goode and Bean, Proc. U. S. Nat. Mus., 1879, 128 (Pensacola); Goode and Bean, Fish. Essex Co., Mass., 1879, 15 (no description); Bean, Proc. U. S. Nat. Mus., 1880, 89 (Washington Market), no description.

Scomberomorus maculatus Jordan & Gilbert, Bull. U. S. Fish Comm., 1882, 106 (Mazatlan, no description); Jordan and Gilbert, Bull. U. S. Fish Comm., 1882, 110 (Panama, no description); Jordan and Gilbert, Syn. Fish. N. A., 1882, 426; Goode and Bean, Proc. U. S. Nat. Mus., 1882, 237 (Gulf of Mexico, no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 268 (Pensacola, no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 594 (Charleston, no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 625 (Panama, no description); Bean, Cat Fish. Exhibition, London, 1883, 51 (Charlotte Harbor, Fla., no description).

Habitat.—Both coasts of America; from Lynn, Mass., to Key West; Mazatlan; Panama. Not recorded from Cuba or any of the lesser Antilles.

3. **Scomberomorus regalis.** Pintado.

Scomber regalis Bloch, Ausl. Fische, 1795, Taf. 385 (after a drawing by Plumier); Bloch and Schneider, Systema. Nat., 1801, 22 (after Bloch).

Cybium regale Cuvier, Règne Animal, ed. ii, 1829 (name only; after Bloch); Cuvier and Valenciennes, Hist. Nat. Poiss., viii, 1831, 184 (San Domingo); Poey, Syn. Pisc. Cub., ii, 1868, 326 (Cuba); Gill, Rept. U. S. Fish Comm., 1871–72, 802 (name only); Baird, Rept. U. S. Fish Comm., 1871–72, 825 (Wood's Holl; no description); Gill, Cat. Fish East Coast N. A., 1873, 24 (name only); Poey, Proc. U. S. Nat. Mus., 1878, 4 (Cuba); Goode, Proc. U. S. Nat. Mus., 1879, 3 (East Florida, no description).

Scomberomorus regalis Goode and Bean, Proc. U. S. Nat. Mus., 1882, 237; Jordan and Gilbert, Syn. Fish. N. A., 1882, 426.

Scomberomorus plumieri, Lacépède, iii, 1801, 292 (after Aubriet's copy of Plumier's drawing).

Cybium acervum Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 186 (in part; type); Poey, Repertorio, i, 1867, 322; ii, 13 (Cuba); Poey, Proc. U. S. Nat. Mus., 1878, 4 (no description).

Habitat.—Atlantic Coast of America; Wood's Holl, Mass.; Key West; Cuba; San Domingo. More abundant southward; rare north of Key West.

4. **Scomberomorus cavalla.**

Guarapucu Marcgrave, Hist. Brasil. 1648, 178 (Brazil).

Cybium cavalla Cuvier, Règne Animal, 1829, ed. 2d (after Marcgrave).

Cybium caballa Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, 187 (Brazil·; Günther, Cat. Fish. Brit. Mus., 1860, 373 (San Domingo); Poey, Report, i, 1867, 322; ii, 13 (Cuba); Guichenot, Sagra, Hist. Cuba Poiss., 1850, 103 (Cuba); Poey, Proc. U. S. Nat. Mus., 1879, 3 (East Florida; no description); Poey, Bull. U. S. Fish Comm.. 1882, 118 (no description).

Scomberomorus caballa Goode & Bean, Proc. U. S. Nat. Mus., 1882, 237 (no description); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 268 (Pensacola); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 549 (Charleston; no description); Jordan and Gilbert, Syn. Fish., 1882, 427 (copied).

Habitat.—Atlantic Coast of America; Charleston; Brazil. A food fish of great importance in the West Indies and Southern Florida. It reaches a much larger size than any other.

The name *cavalla*, first used by Cuvier, has priority over *caballa*.

OCTOBER 7.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-three persons present.

A paper entitled "The Geology of Delaware—Laurentian, Palæozoic and Cretaceous Areas," by Frederick D. Chester, was presented for publication.

The death of Geo. Bentham, a correspondent, was announced.

OCTOBER 14.

The President, DR. LEIDY, in the chair.

Twenty-five persons present.

The death of Charles W. Poultney, a member, was announced.

The following were ordered to be printed:—

PRELIMINARY NOTES ON THE GEOLOGY OF DELAWARE—LAURENTIAN, PALÆOZOIC AND CRETACEOUS AREAS.

BY FREDERICK D. CHESTER.

INTRODUCTION.

During the years 1837 and 1838, Professor James C. Booth, in accordance with an act of the State Legislature, made a geological survey of Delaware, the results of which were published in a report that appeared in 1841. This old memoir is of great value, both from the accuracy of the author's observations and his minute attention to detail; I cannot, therefore, expect to supplant it, my aim being an entirely different one, *i. e.*, to so completely reconstruct our geology as to bring it into sympathy with the results of adjacent States. Professor Booth's great and only fault as a geologist lay in his entire indifference to stratigraphical order; and his classification of deposits according to mineralogical and physical characters, leaves one in utter confusion.

My main object, therefore, is to endeavor to undo the tangles which Professor Booth has unconsciously made, by stating the facts in the briefest and clearest manner possible.

The results, as embodied in the following paper, are preliminary to what is hoped will be a full report upon the State.

GEOLOGICAL OUTLINE.

The formations represented within the bounds of the State are Laurentian (?), Cambro-Silurian, Silurian-Devonian (?), Cretaceous, Tertiary and Quarternary. The relations and positions of the several divisions of the chronological scale can be best represented by the accompanying table (I), also the thickness of each formation. Column 2, with which the Delaware series is compared, is constructed according to what seem the best results, combining home and foreign equivalents. The accompanying map (Pl. V) is drawn upon a scale of four miles to the inch, and is sufficiently large to show all necessary details. A word is here necessary in regard to the boundaries as shown by the map. The lenticular areas which indicate the magnesian marble, can only serve to represent the position of outcrops. Owing to the fact that these calcareous deposits are entirely covered by the micaceous rocks, surface indications offer no means of determining the entire area covered by the former.

I.

PERIODS.	GENERAL SERIES.	DELAWARE SERIES.
QUARTERNARY.	Modern.	Bog Clay or Alluvium.
	Post-Glacial. Glacial. .	Delaware Gravels and Estuary Sands—10–40′.
TERTIARY.	Pliocene. . .	Blue Clay—8–10′. Glass Sand.—40′.
	Miocene. . . .	White, Potters' Clay—10–20′.
	Eocene.	
CRETACEOUS.	Upper.	Middle Marl—189′.
		Indurated Marl—149′.
		Lower Marl Bed—60′.
	Middle.	Sand Marl—90′.
	Lower. (Wealden.)	Plastic Clays—250′.
		Mica Schists and Gneisses.
CAMBRO-SILURIAN.	Calciferous. Potsdam.	Magnesian Marbles. Quartzite.
LAURENTIAN (?)	Laurentian (?)	Syenitic Rocks.

Owing also to the fewness of the outcrops of the several divisions of the Cretaceous, the boundaries had to be drawn from such data as were accessible, which were in some cases abundant, and in others entirely absent. Sufficient is known, however, to make the writer confident of their general accuracy; while the missing links of knowledge could only be supplied by expensive borings.

The Laurentian.—To this belongs the belt of hornblendic rocks above the line of the Pennsylvania R. R., which to the west is narrow but which rapidly broadens to the east, as it extends into Delaware county, Pa., and contracting again to a narrow neck at Chester Creek, there connects with another irregular area occupying all the northwestern portion of Delaware county. This area connects with still another to the north, and to the east of West Chester. This rock is a dark hornblendic gneiss or amphibolite schist, dipping usually to the northwest, rarely in the opposite direction. With it is associated a grayish to bluish gray rock, usually finely crystalline, which has been designated as diorite and syenitic granite by the Pennsylvania geologists. Owing to the absence of petrographical facts concerning this rock, however, nothing definite can be said concerning it. It shades by indistinct degrees into the amphibolite schists, the two varieties probably forming the same eruptive series.

The Cambro-Silurian.—This formation, so largely developed through the counties of southeastern Pennsylvania, has one area in the northwestern part of Delaware, and two smaller exposures. In the northwestern area, a coarse quartzitic rock is found to underlie a highly crystalline magnesian marble. These, as we shall more clearly perceive further on, must be referred respectively to the Potsdam and Calciferous, the latter of which is equivalent to the Lower Magnesian limestone of the West.

The Mica Schists and Gneisses.—To the north of the belt of Laurentian gneisses, and resting upon the latter, is a series of mica schists and granitic gneisses, with which are associated bedded granites, serpentine, and hornblende rocks. They have commonly been referred to the *Mont-Alban*, which, together with the older hornblendic rocks, were called *Azoic*, the two forming a part of the southern gneiss area as known by the Pennsylvania geologists. It will be my aim, shortly, to show that the hornblendic rocks and mica schists do not make two successive formations, within the Azoic, but that, while the former is either Laurentian or Huronian, the latter must be placed above the Trenton, and possibly above the Hudson River, slates. Their exact position in the Palæozoic scale, however, will probably never be determined, owing to the complete absence of fossiliferous remains, due to the extreme metamorphism. The rocks have been subjected to great contortion, the strata having been

pressed either into close folds, or into broad or contracted anticlinal or synclinal flexures.

The Cretaceous.—Resting upon the eroded edge of the Azoic rocks are successive series of plastic clays, sand marls and green-sand, which form quite uniform strata, dipping at a low angle to the southeast. This belt, having a width of 18 miles, extends from the hills to the latitude of Noxontown mill pond, just south of Middletown.

The Tertiary.—The Cretaceous is succeeded by a stratum of white or lead-colored clay, having a thickness of 10 to 20 feet. This continues as far south as Murderkill Creek, and from fossiliferous evidence, must be referred to the Miocene.

South of Murderkill Creek, the Miocene is succeeded by 3 to 10 feet of light or dark blue clay, beneath which is a uniform stratum of fine glass sand, of at least 40 feet in thickness. That all the State south of Murderkill is later Pliocene, I shall endeavor to prove in a future paper upon the younger formation.

All the beds of the Tertiary lie in a nearly horizontal position, dipping at a still lower angle than the Cretaceous, and probably unconformable to the same.

The Quarternary.—Covering most of the foregoing formations, and reaching up the flanks of the Azoic hills to the height of 200 feet or more above tide, is a layer of sand and gravel, which to the north is of a coarse, red nature, and to the south is fine and white. They are called the Delaware Gravels and Estuary Sands, respectively. Along the river and bay shores is also the belt of bog-clay, which is modern, and of more recent origin than the gravels. Also upon the summits of the highest hills in the State are solitary patches of gravel which are evidently older than the continuous stratum to the south. This high-level gravel, in the absence of proper data, has been problematically referred to the Tertiary, and is known as *Bryn Mawr* gravel.

The Crystalline Rocks.

Geographical Position.—Generally speaking, the southern line of the Azoic rocks is the limit of the highlands, but in certain places they extend well into more level regions. Beginning with a point upon the Maryland boundary, a little north of where the latter is cut by the Mason and Dixon line, the limit of the rocks runs in a northeast direction, cutting through the western end of Newark, and following the northern boundary of the town.

Thence it runs close to the south shore of White Clay Creek to a distance of two miles beyond Roseville, where it makes an abrupt bend to the north, until at Stanton the rocks cease to be found. A mile back of the railroad station, they again appear, continuing to a point about a mile back of Newport, where their course turns slightly to the southeast, crossing the Wilmington turnpike just before it is intersected by the Wilmington Northern R. R., thence it follows the turnpike through the southern half of the city, keeping just north of the Pennsylvania R. R., to a point south of Bellevue, where the line cuts the river. From there the Delaware River marks the southern boundary. The area as above indicated may be divided into two pretty distinct belts: (1) the southern belt of hornblendic rocks, and (2) the northern belt of micaceous rocks, with which are associated interstratified beds of coarse grained orthoclase granite, feldspar, quartz and quartzite.

The boundary line between these two belts can be traced very accurately, and is found to correspond pretty closely with the lines of strike. Beginning with the western boundary of the State, the line follows approximately the course previously traced out, but one-half a mile to the north of the same. It continues thus to a point south of Milltown, when an abrupt turn to the northeast is taken, the line crossing the Brandywine only a few miles from the head of the State. It is owing to the northerly course of this line, as compared with the southern limit of the Azoic area, that the northeastern portion of the State is covered more largely with the hornblende, and the northwestern with the micaceous rocks.

The Lithology of the Crystalline Rocks.

The rocks which cover the crystalline area may be classed as follows:—

Micaceous { Granite, Granitic gneiss, Mica schist.

Hornblendic { Amphibolite schist, Blue to gray trap.

Calcareous { Marble, Saccharoidal limestone.

Serpentine.

Quartzite.

Vitreous quartz.

Granite.—This rock, as known in the State, is divided into two classes: (1) that which forms intrusive beds, being a coarsely crystalline orthoclase granite, and (2) that which is nothing more than a highly metamorphosed granitic gneiss, or mica schist, it being a very compact, fine-grained rock. The former variety may be described as an intimate mixture of flesh-colored orthoclase, quartz and muscovite mica, with which are often associated albite and biotite. It occurs as veins, usually bedded, which vary in width from 6 inches to 25 feet, and which, though often continuing in length for several miles, are known to pinch out entirely. The great difference in lithological character between the enclosing rocks and these beds would imply that the latter are veins of plastic injection from aqueo-igneous fusion. That the intrusion of the semi-molten magma was subsequent to the uplifting and crystallizing of the enclosing rocks, is proven by the fact that the latter have, in the vicinity of such veins, suffered considerable disturbance and undue metamorphism at the planes of contact with the intruded mass. The granite is often so highly feldspathic as to be worked exclusively for this mineral, and when the upper portions of such veins are greatly decomposed, diggings have in a few cases been made for kaolin.

One of the most noticeable of these veins of coarse granite is found to cut across the road leading up the Brandywine, about one and a half miles from the head of the State. A large quarry has been opened in this vicinity, where the rock has been worked for feldspar. The vein is not less than 20 feet wide, on the one side of which is a highly metamorphosed mica schist, and on the other hornblendic gneiss. The rock is a mixture of red orthoclase, albite, blue quartz, and muscovite, the crystals being sometimes so large that perfect specimens of feldspar several inches square, can be obtained. Large hexagonal plates of mica, many of them 6 inches across, are also found in abundance. The same feldspar is worked three miles to the northeast, probably from the same vein, as near as could be determined; while in the other direction the intrusive mass seems to lose itself.

Another equally wide vein cuts across the Newark and Avondale R. R., at Tweed's mill, two miles north of Newark. A faulting plane cuts through this intrusive bed, possibly due to its disturbing action.

The same rock is found to continue two miles and a half to the

northeast, outcropping upon the run to the south of Pleasant Hill P. O. Many other instances of granite veins might be cited, but with nothing new regarding them. All of the large veins mentioned above are exclusive of the smaller seams, which vary in width from a few inches to a foot, and which are liable to be found anywhere, and frequently, within the micaceous belt.

The second class of granite—a highly changed gneiss or schist—is a fine-grained rock containing quartz, plagioclase and biotite, with the quartz subject to considerable variation.

It occurs as massive beds, the planes of the stratification being so completely obliterated that the rock resembles a true trap. That it is not trappean, however, is shown by the fact that it is seen to run, by indistinct degrees, into mica schist. Such rocks are usually much broken up, thus testifying to an undue mechanical activity, itself the cause of the extreme metamorphism.

Granitic Gneiss and Mica Schist.—These two species represent the extremes of variation in what is the characteristic rock of the micaceous belt, which has gone by the generally applicable name of gneiss. These two rocks so merge into each other that specific designation is often difficult. The typical mica schist may be described as a very schistose biotite rock, usually highly garnetiferous, and containing a variable proportion of quartz. Sometimes this highly micaceous rock contains a very small proportion of feldspar, which can often only be seen as a kaoline substance in the decomposed product; and if the absence of feldspar be characteristic of mica schist, then with the presence of feldspar the true schists begin to run into gneiss.

Hornblende Rocks.—The hornblende rocks, as a class, may be divided into the basic and acidic, or into those rocks of which the predominating constituent is either hornblende or feldspar. To the former belong the dark varieties of amphibolite schist and syenitic gneiss, and to the latter belongs the light, highly acidic bluish gray trap so characteristic of the northeastern part of the State. Between these two extremes there is every shade of gradation, showing some petrographical relation between them. The dark varieties of amphibolite schist vary in color from a blue to a dull black, from coarsely crystalline to compact. The predominating element is hornblende, with which is associated a small proportion of plagioclase, and sometimes blue quartz. This rock, which shows a more or less eminent lamination, is found

to merge into a massive rock of the same composition. When the proportion of hornblende increases, it becomes so great as to make up, apparently, the entire composition, in which case the syenitic gneiss runs into the hornblende schist or into massive hornblende rock. The bluish gray trap may be described as follows: in color it varies from a light to a dark bluish gray; in texture, from a coarsely crystalline to one fine-grained, homogeneous and trappean in character.

Lithologically, the rock is composed of plagioclase, feldspar and hornblende, with frequently a small proportion of blue quartz and biotite.

Massive hypersthene has often been found in fine orthorhombic crystals, entirely replacing the hornblende, and is associated with a plagioclase showing the most eminent striation. Thus, from microscopical examination, the rock seems to range from a *quartz diorite* to a true *hyperite*, although no true knowledge of the rock can be had until a thorough microscopical study is made. Professor G. H. Williams,[1] of Johns Hopkins University, has proven a similar rock, in the vicinity of Baltimore, to be a *hypersthene gabbro*, which also runs by indistinct stages into a true *amphibolite schist*. He has also shown that the *amphibolite* is the result of a paragenesis taking place in the *gabbro*, the hypersthene and pyroxene found in the latter being altered to hornblende, and thus producing the gradual passage of gabbro into amphibolite. Whether some such alteration as this can account for the passage of the bluish gray trap into amphibolite schist is quite within the range of possibility. This question has already become a subject of investigation by the writer, and it is hoped that much light will be thrown upon it.

Calcareous Rocks.—To this class belong those rocks generally called crystalline limestone, of which there are two varieties, namely, saccharoidal limestone and marble. They are found at three known localities, one near Pleasant Hill, one at Hockessin and another near Centreville, both varieties occurring together.

The marble may be described as very coarsely crystalline. It is very compact in texture, of superior hardness, and is always heavily and closely bedded. The variety called saccharoidal limestone is more granular and extremely friable. It is also

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[1] Am. Jour. of Sci., October, 1884, and Johns Hopkins Univ. Circular, April, 1884.

less pure, being often colored by oxide of iron or organic matter, and is much more thinly bedded, the thinner seams being interstratified with the heavily bedded marble.

Serpentine.—About six miles northeast of Wilmington a huge dike of serpentine runs with the micaceous schists. Its length can be traced by outcropping boulders for a distance of a mile, with a width of a quarter of a mile. The rock varies from one tough and massive to one soft and highly decomposed, with which are associated talc and magnesite.

Vitreous Quartz and Quartzite.—The former rock occurs as regular thin or massive seams interstratified with the micaceous rocks. It varies from a glassy colorless variety to one of milky and opaque whiteness. The quartzite, which is found in the northwest corner of the State, underlying the limestone, is probably of Potsdam age. It is a very coarse quartzite rock, which contains, frequently, crystals of *tourmaline*, *fibrolite* and *actinolite*.

Structural Relations of the Crystalline Rocks.

Strike and Dip.—The rocks of this formation, except in a very few cases, are all stratified with variations of bedding, from that as thin as slate in the mica schists to that so heavy as to resemble massive trap intrusions. Both strike and dip are subject to great variation. A dip to the southeast for a long distance, with an opposite dip along a section only two miles and a half to the northeast, can be accounted for only by supposing an unequal thrust from the direction of the contorting force. In fact, out of five different sections made across the Azoic belt at various points of its length, no two showed the same arrangement of strata—from which we conclude that the thrusting force must have acted very unequally along the entire length of the belt, sometimes merely tilting the strata; again, standing them on edge, and yet again, completely overturning them; in some places pressing them into close folds for a part or the entire length of the section, in others leaving gentle or abrupt anticlinal and synclinal folds.

Both strike and dip are also found to be subject to variations from the disturbing action of granitic intrusions. At Dixon's spar quarry the change is from N. 55° E. to N. 22° E. At Pleasant Hill a granitic vein cuts through the limestone, which causes a

disturbance from N. 55° E. to N. 10° E. Excluding cases of local distortion, however, the crystalline rocks range in strike between N. 45° E. to N. 60° E., and in dip from nearly vertical to nearly horizontal.

Dikes.—We have already spoken of the granite and serpentine as intrusive, forming in certain cases true beds, and again, showing genuine vein structure with numerous branchings. Regarding the structural relations of the bluish-gray trap, there are as yet some doubts. The geologists of the Second Pennsylvania Survey have spoken of it as forming massive trap intrusions between hornblende gneiss—of which the latter is metamorphic.

This theory, I am inclined to think, will prove to be a mistaken one. In Delaware, as we have said, the gray acided rock runs by indistinct gradations into true amphibolite schist, the many stages of variations being sometimes witnessed in a single quarry, without the slightest structural distinctions. Seams of the gray trap have been seen running through the black hornblende gneiss, but without the least signs of intrusion. That the bluish gray trap may occupy irregular patches more or less lenticular, is no doubt true, but the latter can in no sense be regarded as forming dikes between a metamorphic schist; on the other hand, all the rocks of the hornblendic belt, from the most acidic gray trap to the true amphibolite schist, belong to a single series of eruptive rocks, having wide lithological variations. That these variations may be the result of a subsequent paramorphosis taking place in the bluish gray trap is quite possible; it is therefore to be hoped that present petrographical studies of the hornblendic rocks of the State will throw more light on this important question.

Contortion of Strata.—The crystalline rocks offer the most complicated and striking examples of contortion, presenting nothing, however, which is not characteristic of all metamorphic areas. Close folding is the form generally seen, the line of bedding being either straight, gently or violently contorted. Abrupt anticlinal and synclinal folding is also common, these complex folds being, however, very irregular and much twisted.

Age and Stratigraphical Order.—The crystalline rocks may be divided into four groups, which have a fixed stratigraphical relation to each other, namely, the hornblendic, the micaceous, the calcareous and the quartzitic.

The normal order of arrangement of these strata, and thereby

their relative age, is a point upon which there has been much difference of opinion, owing to the confusing arrangement of the strata throughout some of the counties of southeastern Pennsylvania. Notwithstanding such difficulties, the geologists who have discarded broad generalizations, and devoted themselves to the study of local details, find the way gradually opening to a better understanding of the truth; and the early presumption that the mica schists and gneisses are of Palæozoic age, is rapidly becoming a matter of general acceptation. The latest results of geological study in Pennsylvania, together with the observations of the writer throughout Northern Delaware, tend to show quite conclusively that the crystalline rocks represent the following ages: (1) The Laurentian (?) including the rocks of the hornblendic belt; (2) the Potsdam, to which the quartzitic and sand rocks belong; (3) the Calciferous, including the magnesian marbles, and (4) the age of the mica schists, which must be placed somewhere above the Trenton, and, according to Mr. Charles E. Hall, above the Hudson River, slates. With these points in view, we shall proceed with the demonstration.

The Laurentian (?)—The so-called Laurentian area of Delaware is but a continuation of identical areas in southeastern Pennsylvania, within the Philadelphia belt, which, according to Mr. Hall, are three in number, each connected with the other by a narrow neck, and each situated successively to the northeast. The southernmost of these areas is of lenticular shape, reaching from Chester Creek, and spreading out over the southern part of Delaware County, whence it extends into the State of Delaware, as shown upon the map. Northeast of this patch, and to the northwest of Media, is another area of irregular form, while a third—a long east and west belt—runs from West Chester, south of Conshohocken, eastward to the Delaware River, near Trenton. Thus the Delaware Laurentian forms the southernmost tongue of the one Laurentian area of the Philadelphia belt, the upper portion of which has been for a long time known as the *Third Belt* of Rogers. As regards the age of the *Third Belt*, Mr. Hall says, "The rocks of the *Third Belt* are identical with the granitoid and syenitic rocks of the Welsh Mountain, north of the Chester County limestone valley. These rocks of the Welsh Mountain are similar in all respects to the crystalline rocks extending into

Pennsylvania from New Jersey. In New Jersey they are identified as belonging to the Laurentian."

With these points in view, I have followed Mr. Hall, and placed the syenitic rocks of Delaware in the Laurentian, although I feel that it is, at best, but a problematical designation. Any positive declaration upon this point would be premature, until a more thorough structural and petrographical study has been finished, together with a comparison of results from diverse localities. Throughout southeastern Pennsylvania the hornblendic rocks are always stratigraphically the lowest, and such is the case in northern Delaware.

The general dip of the syenitic rocks, upon the flanks of which rest the strata of the micaceous belt, is, in the latter locality, to the northwest. In the western part of the State, however, the hornblendic rocks have experienced an overthrow, whereby they dip to the southeast, in which case the hornblendic rocks are apparently the younger. This peculiarity need not, however, be misleading as to true stratigraphical order. Putting aside all questions of position of strata, one must note the decidedly primitive aspect of these rocks, which, in lithological characters, are identical with the rocks of more northern portions of the Laurentian area.

The Potsdam.—In the northwestern part of Mill Creek Hundred, a triangular area of Potsdam sandstone is seen upon the map, which, rising from beneath a patch of Bryn Mawr gravel, extends into Pennsylvania, and is best exposed beyond the State line. At Nivin's limestone quarry, a mass of quartzite forms what is clearly an anticlinal fold, over which is a corresponding anticlinal of magnesian limestone. The anticlinal structure of the quartzite is further shown at a few other points, where dips both to the northwest and southeast are noted.

The Calciferous.—Mr. Hall divided the limestone of southeastern Pennsylvania into two groups, namely, the Calciferous magnesia limestones and marbles, and the possible Trenton limestones and slates, the former comprising the rocks of the Chester County limestone valley, and several outlying troughs to the south, the latter those alternations of slate and limestone which form the outer border of the Calciferous belt.

The limestone areas of Delaware belong to the lower of the above groups, or to the Calciferous of Mr. Hall, the equivalent of

the Lower Magnesian limestone of the West. The magnesian marble which outcrops beyond the State line, at Nivin's, runs into Delaware, and appears at the surface in the Jackson quarry at Hockessin. Here the rock forms a clearly defined anticlinal fold. The bending, both to the northwest and southeast, being observed within the cutting. The limestone is overlaid by the mica schists which, to the north of the pit, dip to the northwest, and to the south, southeast, forming an anticlinal fold capping the limestone.

To the southeast of Centreville, the limestone occupies the same stratigraphical position as in the case just mentioned. At Pleasant Hill the bending of the schists over a saddle of limestone is beautifully shown in the quarry cutting, furnishing clear proof as to the superior position of the mica schists.

The Mica Schist and Gneiss.—The inference that these rocks were primal, was based largely upon their lithological similarity to many of the older crystalline schists. They were hence referred to the White Mountain, or the Rocky Mountain, series. But lithological similarities must invariably bend to higher statigraphical evidence. In Delaware the micaceous rocks overlie the limestone, and no readjustment of position can make the arrangement otherwise. They are, therefore, younger than the limestone, which, in its turn, is younger than the underlying Potsdam.

The Calciferous limestone can hardly be referred to any other position, and, invariably underlying the schists, the latter must begin somewhere in the Silurian, and, possibly, mount as high up as the Devonian.

The Cretaceous.

Geographical Extent.—The Cretaceous of Delaware, a continuation of the same formation as developed in New Jersey, extends across the State as a northeast and southwest belt, with a breadth of 18, and a length of from 15 to 20 miles, covering a total area of about 250 square miles. The northern limit of the belt, laid down on the map, has already been traced out as marking the southern boundary of the Laurentian. The southern limit runs a little to the south of, and parallel with, Appoquinimink Creek, cutting through the centre of Noxontown mill-pond, and thence proceeds in a straight southeasterly direction.

Subdivisions.—The formation may be divided into a number of subdivisions, based upon lithological grounds, the period of sedimentation extending through the whole Cretaceous; *i. e.*,

Lower, Middle and Upper, of the English geologists. The divisions can be best represented by the following table, which is also

II.

<table>
<tr><td rowspan="8">UPPER CRETACEOUS (Chalk).</td><td rowspan="3">Middle Marl Bed.</td><td>Yellow Sand.</td></tr>
<tr><td>Shell Layer.</td></tr>
<tr><td>Pure Green Sand.</td></tr>
<tr><td rowspan="2">Indurated Marl Bed. . . . .</td><td>Indurated Marl.</td></tr>
<tr><td>Red Sand.</td></tr>
<tr><td rowspan="3">Lower Marl Bed.</td><td>Black Argillo-Micaceous Marl.</td></tr>
<tr><td>Shell Marl.</td></tr>
<tr><td>Cretoidal Marl.</td></tr>
<tr><td>MIDDLE CRETACEOUS (Upper Green Sand, Gault).</td><td>Sand Marl. . .</td><td>Sand and Clay Marls.</td></tr>
<tr><td rowspan="2">LOWER CRETACEOUS (Wealden?).</td><td rowspan="2">Plastic Clays. .</td><td>Red Clay.</td></tr>
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</table>

constructed with a view of showing the relative thickness of each of the groups. In the classification the plastic clays have been placed in the Lower Cretaceous, and are probably the exact equivalent of the Wealden, while the marl deposits, ranging from the Lower to the Middle Beds, can, upon palæontological grounds, be referred with considerable confidence to the Upper Cretaceous, or Chalk. The Sand Marl formation can at best be placed in but an intermediate position, but is probably nearly akin to the marls, all of the fossils ever found within the sand marls of New Jersey having been the characteristic species of the marl beds proper.

Structure.—The different subdivisions of the Cretaceous form uniform beds, dipping at a low angle to the southeast. Having been successively deposited upon a gently sloping bed, they have remained in the same position, with no subsequent disturbance. The general direction of *strike* can be seen from the trend of the various belts. A line joining the point of contact between the Cretaceous, at Newark, with a similar point back of Newport, upon nearly the same level, ran N. 72° E., which course, being approximately parallel with the lines of the lower belts, may fairly represent the strike of the formation. The *dip* was determined with great accuracy at Summit Bridge, about midway of the width of the Cretaceous. At this place the canal excavation has reached a depth of 70 feet, and continues several miles to the westward, with gradually lowering banks. Upon both sides of this wide cutting, the marl outcrops as a well-defined layer, and as any number of lines in the direction of the dip can be obtained, the amount of pitch can be accurately determined. As the transit could always be placed upon either bank in front of the escarpment of marl, and the other side could be easily seen, the operation of determining the difference in level between the two outcrops, on a line running S. 30° E., was not difficult. This difference in level, combined with the angle of depression, as determined by the vernier, would give the data for ascertaining the distance between the outcrops, the latter of which varied from 300 to 400 feet. The results of the observations give a dip of 45 feet to the mile.

Plastic Clays.

This formation is the thickest member of the Cretaceous. Its southern line begins a few miles south of New Castle, and extends

in a southeasterly direction to just below Red Lion, crossing the railroad between Porter's and Kirkwood, and cutting the State line two miles north of Chesapeake City. Although of so much importance, it is, owing to the great thickness of the overlying gravels, rarely exposed, and even when more favorable opportunities are offered, but a few feet of the characteristic Red Clay appear above the surface. The formation is divided into the uppermost Red Clays, and the lowermost White Clays, of which the former is the deposit commonly exposed.

Red Clay.—This is a highly plastic clay, of a vermilion-red color, remarkably free from grit, and cutting with great smoothness. It is identical with the red terra-cotta clays of Perth Amboy, N. J., and may prove to be their equal in quality. The Red Clay forms uniform beds, with which are sometimes interstratified thin seams of fire-clay, making a total thickness of at least 50 feet. *White Clays.*—The series of white clays and sands lying beneath the stratum of red, reach to a great depth below the surface, and have not yet been wholly penetrated by the deepest boring made. The outcrop is upon the lowest ground, of which the only locality discovered lay a little to the south of New Castle, on the river shore. Here the white clay outcrops for a depth of from 10 to 15 feet, giving the following section:

1. Sandy fire-clay, . . . 3 feet.
2. Mottled clay, ... 3 feet.
3. A very pure fat fire-clay at water-level.

The lowermost clay of this section is of an unusually fine quality, and has in past years been worked below water-level, and shipped to Trenton potteries. From this exposure we are enabled to see that the White Clay series, outcropping as it does at water-level, covered by a red stratum, and again by some 30 feet of gravel, is entirely out of the reach of study; yet the presumption that it does lie deeply buried is beyond controversy. Our only means of studying the White Clay series is by means of borings, which are very rare, and in no cases have accurate records of the deposits passed through been preserved. We only know that the borings yielded alternate layers of white clays and sands to a depth of 200 feet. We therefore judge that this series presents strong analogies to the white clays of New Jersey.

SAND MARL.

The belt of sand marl runs from the river course to the south of New Castle, gradually tapering in breadth as the Maryland boundary line is reached. The southern limit of the belt, starting at Delaware City, cuts the north corner of St. George's, and keeps about a mile above the canal for the remaining distance across the State. It may be described as a yellow sand, of a greenish tinge, comprising a yellow siliceous sand mixed with some green sand and a variable proportion of argillaceous matter. No data are at hand for determining its thickness, except the imperfect method of using width of outcrop and angle of dip, according to which we find the sand marl stratum to have a depth of 90 feet.

MARL BEDS.

The marl beds cover a comparatively small area in the State, and are practically limited to that division of New Castle county called St. George's Hundred.

The first important outcrops of green sand occur along the Delaware and Chesapeake Canal, the channel of which cuts deep into the formation. Its northern limit, as determined by old marl pits, runs approximately parallel with the canal, keeping a distance of from a quarter of a mile to a mile. From this line the marl extends southward to another boundary parallel with, and about one mile south of, Appoquinimink Creek, where it gives place to the Tertiary clays.

Subdivisions.—The divisions of the green sand formation are found, with two exceptions, to correspond with those made by the New Jersey Survey. In the first place, what is called by Professor Cook the Upper Marl bed, is in Delaware, entirely absent, and in the second place, the so-called *Red sand* is either entirely absent, or represented, as in the eastern part of the State, by a much thinner stratum than is found in New Jersey. This scanty development of the *Red sand* is, however, compensated for by a greater thickness of the *Indurated green marl*, which, in Delaware, becomes the prominent parting layer between the middle and lower marl beds. The chronological chart of the Cretaceous (II), will show the divisions of the marl beds as found in the State.

LOWER MARL BED.

This stratum, which extends as a narrow belt on each side of the canal, is found to outcrop along the entire length of the

same, rising about a foot above the surface of the water, and, farther west, to a height of 20 feet. The several subdivisions of the lower marl will be treated in the order of their age.

Cretoidal Marl.—This lowest layer is a tough, bluish black marl, which, upon drying, turns to a lighter ashen or earthen color, when it is found to be made of a large amount of green sand, siliceous sand and argillaceous matter. The solid particles are coated with chalky carbonate of lime, which, under the microscope, appears as a fine white powder of a granular character, but often light and flocculent.

Shell Layer.—The cretoidal marl is always found beneath a layer of shells or shell marl, having a thickness of about 3 feet. In fact, the shells are usually mixed with a greater or less quantity of the black earthy marl having the characters of the cretoidal variety. The shells are usually the characteristic species of the New Jersey equivalents, the most abundant being the clumsy *Exogyra costata* with *Pychnodonta vesicularis* and *Ostrea larva.*

Black Argillaceous and Micaceous Marl.—This layer, overlying the shells, in its lower part possesses somewhat the characters of the *cretoidal marl.* To the west of the Delaware railroad, however, it rises well out of the water of the canal, and assumes a distinctly argillaceous nature, becoming a black micaceous clay. It also shows an entire absence of calcareous matter, and possesses a decidedly styptic taste, due to the large quantity of sulphate of iron in the percolating waters. This argillaceous marl, when examined in the dry state by a glass, is found to be composed of minute sharp glassy particles of quartz, coated with a grayish dust, and associated with a few green sand particles of unusual fineness, together with a considerable quantity of minute scales of muscovite.

Thickness.—Fortunately we have sufficient evidence for measuring accurately the thickness of the lower marl bed. The belt has an average breadth of 1½ miles, which, with a dip of 40 feet to the mile, would give a thickness of 60 feet for the stratum. At Summit Bridge, the black marl outcrops to a height of 42 to 47 feet. Calling it 40, and adding this to 15 feet of marl in Higgin's pit, on much lower ground between St. George's and Delaware City, we get a total of 55 feet. Since the 15 feet excavation at the latter place failed to entirely penetrate the

marl, we may call 60 feet a safe estimate for the thickness of the lower marl bed. Of this total, more than one-half is represented by the argillo-micaceous layer, and the remainder by the thin shell layer, and the lowest cretoidal marl. There is one reason why the thickness of the lower marl stratum, as developed at Summit Bridge, should be employed in a calculation of the thickness, rather than the smaller figures obtained farther to the east or west. Summit Bridge is on the *dividing ridge.* From this meridional line, the land slopes to the east and west. The marl, therefore, offers a diminishing thickness of outcrop as the river is approached, owing to the erosion of the upper argillo-micaceous stratum, which, in the neighborhood of St. George's, and thence to Delaware City, has been thinned down to a thickness of only a few feet. It is for this reason that the upper portion of the lower marl bed is so extensively developed at the western end of the belt, while the lower portion of the same formation is confined to the eastern portion of the belt. Since the upper argillo-micaceous stratum is a poor, and even objectionable, material for fertilizing purposes, while the contrary may be said of the lower cretoidal variety, the locality for marl diggings must lie east of the railroad bridge.

INDURATED MARL BED.

The northern limit of this belt, which is also the southern limit of the lower marl bed, starts near the mouth of Scott's run, and thence keeps parallel with the canal to the railroad, when it begins slightly to diverge, cutting the headwaters of the northern branch of the Bohemia River. The southern limit of the belt can only be approximately outlined, but as can best be determined runs from Port Penn through the headwaters of Drawyer's Creek, and crosses the Maryland line four miles below the head of Bohemia River. The indurated marl stratum is divided into two layers, the lower red sand, and the upper indurated marl.

Red Sand.—The formation which has been called the indurated marl bed is the equivalent of the red sands of the New Jersey geologists, it being, in both cases, the prominent parting layer between the lower and middle marl. Along the south side of the canal, between the railroad bridge and St. George's, a soft reddish yellow sand of uniform character rests upon a stratum of black marl. It is developed to a considerable thickness in the neigh-

borhood of the latter town, and is characterized by the numerous particles of green sand contained in it. The thickness could not, however, be accurately determined, running as it does, indistinctly into the overlying gravels. West of the railroad, the deposit thins out entirely, and does not again appear. Along the ravine made by Scott's Run the red sand has been found lying upon the shell marl, running to the south into a black decomposed green sand. Notwithstanding the deposit of red sand, which outcrops along the south shore of the canal, the shell marl is dug by several parties on a strip along the same side, and for this reason, I have extended the southern limit of the lower marl belt slightly to the south of the southern shore of the canal.

Considering the foregoing facts, the writer with some trouble that cannot well be removed, has referred the reddish yellow sand stratum to the red sand of Prof. Cook. This red sand occupies a narrow strip along the south side of the canal, to the east of the railroad, and runs to the south beneath the overlying stratum of decomposed marl, by which nearly the whole area of the bed as previously marked out, is covered. From this we see that the true red sand, which is so extensively developed in New Jersey has a less thickness in Delaware, but is replaced by the indurated marl, which in New Jersey is found more thickly exposed, but occupying the same stratigraphical position above the red sand.

Indurated Green Sand.—This marl attracts from the observer more attention than any other, coming to the surface as it does in numerous localities, and having been extensively worked for its pre-eminent qualities as a fertilizer.

Already in a state of partial decomposition, the decay rapidly progresses by the removal of the potash, and the oxidation of the ferous salt of iron, or its direct solution by carbonated water. Generally speaking, the marl in the bed is of a black, loamy nature which, when dry, assumes a brownish or grayish tinge. It is made of a variable quantity of green sand, with a large proportion of siliceous sand. In some places the marl is found to contain a large amount of argillaceous matter, while again it is extremely clean and dry. It differs entirely from the lower marl, by containing no carbonate of lime in the pulverent state; but in certain places the deposit abounds in shells, which renders it comparable with the shell marl of the former formation.

Examined with a glass, the grains of indurated marl prove of

a brownish color, and very rough and irregular, apparently the effect of weathering. The grains can easily be crushed by the finger-nail, thus exposing the internal green color. The granules are coated with a layer of brown oxide of iron, within which shell exists the unchanged nucleus of glauconite.

The *Indurated Marl*, unless finely pulverized, has a lumpy tendency, caused by numerous grains of green sand cemented by the brown oxide of iron. In fact, the marl has, at certain points, been almost entirely changed to brown oxide of iron, while in other cases, seams of the latter penetrate the mass of the green sand. Prof. Cook is of the opinion that the red sand of New Jersey is due to the decomposition of green sand, whereby the soluble salts have been carried away, leaving the insoluble siliceous sand and red oxide of iron. We may, therefore, regard the belt, which in New Jersey is called the red sand, and in Delaware the indurated marl. as a true marl belt in a greater or less degree of decomposition; and while a slightly indurated green sand may entirely differ mineralogically from a red siliceous sand, the difference is after all only one of degree of decomposition.

Middle Marl Bed.

This belt crosses the State with a uniform breadth of three and a half miles, the northern line running from Port Penn, a little north of Drawyer's creek, and crossing the State line four miles south of the Bohemia River. The southern line crosses the centre of Noxontown mill-pond, keeping parallel with and a little south of Appoquinimink creek. The middle marl bed (see II) is divided into three very distinct layers: (1) A lowermost pure green sand; (2) an intermediate layer of friable shells, and (3) an upper yellow or reddish yellow sand. The characters of these several strata will be considered as follows:—

Green Sand Layer.—This lowermost subdivision of the middle marl bed occupies the main width of the belt to the north of Appoquinimink Creek, and exhibits its principal exposures along Drawyer's Creek and Silver Run, where its characters may be well studied. It differs entirely from any of the foregoing varieties, in that it is entirely free from calcareous matter, and shows none of the general induration so characteristic of the previous formation. On the contrary, it is a very dry, pure green sand, which varies in color from a deep bluish to a yellowish green, the latter shade being due to a considerable admixture of siliceous sand.

The extreme dryness of this marl, compared with the preceding varieties, is owing to the complete absence of argillaceous matter. The grains, when examined, are smooth and well rounded, and although frequently so soft as to be easily crushed by the nail, show no evidence of chemical decomposition.

Shell Layer.—This intermediate, well-defined layer, is best exposed at the head of Noxontown mill-pond, and along the south side of Appoquinimink Creek. In thickness it varies from 3 to 10 feet, being entirely made up of white friable shells, tightly packed together, the most common of which are *Terebratula fragalis* and *T. Harlani*, with *Pychnodonta vesicularis.*

Very often the upper part of the shell layer has lost its carbonate of lime, which is replaced by brown oxide of iron. At the head of Noxontown mill-pond, the white shell layer, of which the upper part is ferruginous, rises 5 to 6 feet out of the water, capped by a yellow sand marl.

Yellow Sand.—This is the uppermost layer of the Middle Marl Bed, and is always found associated with and overlying the shells. It may be described as a yellowish or reddish sand, containing a small and variable proportion of glauconite, the latter often becoming so predominant as to give the deposit a decidedly greenish tinge.

DIORITIC TRAP.

Three miles to the south of Newark, Delaware, Iron Hill rises from the Cretaceous plane, the one conspicuous object for 10 miles or more. Running in a generally northwest and southeast direction, it has a length of over 3 miles, a width varying from 1 mile to 1½, and a height of 225 feet. The flanks and summits of this hill are covered with boulders of diorite and cellular quartz. On the south side, about half way up, is seen the outcrop of a bedded mass of serpentine rock, with a strike following the trend of the hill. An examination of the loose fragments of green rock lying upon the surface showed them to be composed of a number of indefinite chloritic and serpentine materials in a state of partial decomposition. As the greenish fragments were also observed to run into unchanged trap, occurring as huge outcropping boulders, the proof appeared conclusive that the serpentine rock had been due to the alteration of the hornblende in the dioritic trap. Following the hill in its northwest course, we find the same rock crossing the railroad, along the cutting of which the nature of the dike is revealed.

Here we first pass some 200 feet of a soft greenish clay, which rises as walls 20 feet high. Fragments of the serpentine rock, on the surface above the railroad cutting, showed it running into unchanged diorite. Lying next to the serpentine rock was 50 feet or more of both compact and cellular quartz, standing upon edge, and striking to the northwest. It was completely impregnated with minute specks and octahedrons of magnetite, which exhibited their decomposition by numerous minute cells filled with iron oxide. The cellular quartz, associated indiscriminately with the compact, was literally honeycombed, the great cells being partially filled with ochrey powder. West of the quartz occurred a thinner development of the serpentine, offering the same features as before. With these facts, we are led to regard the exposure before us as a highly changed dioritic dike, in the centre of which is a huge mass of ferruginous jaspery quartz, from which we interpret the structure of the whole hill. Attaining the summit, we find several large pits worked for iron ore. One of them, wrought by George Whitaker, has walls of soft greenish serpentine earth rising some 40 feet, in which are imbedded boulders and fragments of cellular ferruginous quartz and iron-stone, together with a considerable admixture of ochrey powder and granular limonite. The economic value of the workings consists in washing the serpentine earth, and extracting the limonitic materials. Near the wash-house the yellowish green rock is seen to outcrop with a strike to the northwest. Several of the pits on the hill offer much the same features, while some of them contain a greater abundance of the boulders of cellular quartz. The method of formation of the crusts of iron-stone may be determined by an examination of the numerous quartzose boulders. It consists in the segregation of iron oxide as tortuous veins within the substance of the rock, set free by the complete disintegration of the latter; while the powdery and granular limonite has resulted from an oxidation of the magnetite which so completely impregnates the jaspery quartz. Associated with the boulders of trap, are certain foreign materials belonging to the drift. Imbedded within the serpentine earth of Whitaker's pit, are several large decomposed boulders of granite. Upon the summit of the hill, a large boulder of dark limestone was also found, besides various other materials belonging to the boulder drift so universally scattered over the State.

OCTOBER 21.

MR. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-nine persons present.

The following papers were presented for publication:—

"On the Cuspidiform Petroglyphs, or so-called Bird-track Rock-Sculptures, of Ohio," by D. G. Brinton, M. D.

"Preliminary Observations on the Brain of Menopoma," by Henry F. Osborn.

OCTOBER 28.

The President, DR. LEIDY, in the chair.

Thirty-nine persons present.

Organisms in Ice.—Prof. LEIDY stated that a member had placed in his hands, for examination, a vial of water obtained from melting ice which is used for cooling drinking-water. From time to time, among some sediment taken from a water-cooler, the gentleman had observed what he supposed to be living worms, which he suspected were introduced with the water into the cooler, and not with the ice. Upon melting some of the ice alone, the worms were still observed, and the water submitted for examination was some that was thus obtained. Prof. Leidy was surprised to find a number of worms among some flocculent sediment, mainly consisting of vegetal hairs and other debris. Besides the worms, there were also immature Anguillulas, and a number of *Rotifer vulgaris*, all living. It would appear that these animals had all been contained in the ice, and had been liberated on melting. It was an unexpected source of contamination of our drinking-water, that Prof. Leidy had previously supposed to be very improbable. The little worms he was not familiar with.

They belong to the family of Lumbricidæ, and probably may be an undescribed species of *Lumbriculus*. They are white, or colorless, from 4 to 6 millimeters long, by a third of a millimeter in thickness. The body is divided into thirty segments, bearing podal spines, which form four rows, with three in each fasciculus, and divergent. The spines are curved at the root, pointed at the free end, and measure 0·05 to 0·06 mm. long. The upper lip is blunt conical; the terminal segment truncate. There appears to be no distinct girdle, but the third, fourth, and fifth segments contain capsuligenous glands and other organs pertaining to the sexual apparatus.

Several dead worms swarmed in the interior with large, ovate, beaked, ciliated infusorians measuring from 0·05 to 0·06 mm. long by 0·04 to 0·048 mm. broad.

Chapter I, Article 6, of the By-Laws was amended by the addition of the following:—"Neither the building occupied by the society, nor any part of the site or ground pertaining thereto, shall be sold, leased, encumbered or charged in any manner whatever, nor shall any apartment or space in the Academy or adjacent ground be assigned or appropriated permanently to the exclusive use of any person or to the accommodation of any special collection or collections, unless the proposition in this connection be in writing, signed by at least five members, presented at a stated meeting of the Academy, referred to the Council for examination and report—which report shall be considered as special business, to be acted upon at a subsequent stated meeting, to be held at least twenty-six days after that at which the report of the Council has been read, the date to be fixed by resolution; but no action shall be taken thereon until after full notice thereof and of said date shall be given to the members by advertisement once a week, for three weeks in two daily newspapers of general circulation in Philadelphia, and by written or printed notice by mail or otherwise to all the members whose residences or places of business shall be known to the Recording Secretary. At such meeting the measure proposed may be considered and adopted by two-thirds of the members present at that meeting, or at any subsequent adjourned meeting for that purpose, provided that at least eighty members be present and vote; and provided also that nothing in this article shall be so construed as to change, alter or repeal Art. 5, Chapter XI, or release the curators from the charge and care of collections, as provided for in these by-laws."

Chapter XVI, Article 4, of the By-Laws was amended as follows:—In the third line, after the word "inclusive," insert the words "except Article 6, Chap. I" and add the followings words or paragraph:—"Article 6, Chap. I, may be amended, altered or repealed by two-thirds, upon a yea and nay vote of not less than eighty members, at a meeting called to consider that special business, after advertisement and individual notification of the members, in manner and form specified in said article, but not otherwise."

The following were elected members:—George Fales Baker, W. B. Scott, Edmund J. James, and H. LaBarre Jayne.

The following were elected correspondents:—G. Vom Rath, of Bonn, and Geo. E. Dobson, of London.

The following were ordered to be printed:—

PRELIMINARY OBSERVATIONS UPON THE BRAIN OF MENOPOMA.

BY HENRY F. OSBORN, SC. D.

This is the second of a series of papers[1] upon the brains of the American Urodela. In the study of *Menopoma*, I have detected numerous errors in the first paper upon *Amphiuma*,[2] and my attention has kindly been called to others by Prof. Wilder and Dr. E. C. Spitzka.

The brains of *Amphiuma* and *Menopoma* are even more alike in their internal than in their external structure; while the reverse is the case in the comparison of *Menopoma* and *Menobranchus*, which resemble each other very closely externally, but in longitudinal section present important differences.

The greater accuracy of the Menopoma work is due to changes in technical methods. Before hardening, the brains were inflated with Müller's fluid, so as to preserve the natural proportion of the cavities. After treatment with alcohol, they were placed for a week in dilute carmine. Calberla's egg-mass was employed as before, except that the ventricles were injected with the mass before hardening. The delicate parts of the brain-roof were thus retained. It appears now that celloidin may be used for this purpose to equal, if not to greater, advantage in results, and with considerable economy of time. The sections were cut in absolute alcohol, were then floated upon a slide in consecutive order, from twenty to fifty at a time, and were covered with a delicate slip of blotting-paper during treatment with oil of cloves. These changes greatly improved the three series, which were obtained in as many planes—horizontal, transverse and vertical to the long axis of the brain.

EXTERNAL STRUCTURE (Pl. VI, figs. 1, 2, 3).

With a single exception, and that an important one, the brain of *Menopoma* approaches closely the typical brain. The seg-

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[1] Many of these results were presented in the Biological Section of the American Association, September, 1884.

[2] Preliminary Observations upon the Brain of Amphiuma. Proc. Phila. Acad. Nat. Sc., July, 1883.

mental[1] parts are clearly differentiated from each other in regular succession, beginning with the olfactory lobes or Rhinencephalon, the Prosencephalon, the Diencephalon, the Mesencephalon, the Epencephalon and Metencephalon. This was not found to be the case in *Amphiuma*, where the Rhinen- and Prosencephala and Dien- and Mesencephala are barely distinguishable. The exception above noted is that, the epiphysis does not appear upon the external surface, but, as we shall see, is altogether wanting, while a vascular plexus lying between the hemispheres offers a very deceptive imitation of this important structure. The hypophysis and infundibulum, however, have a striking development.

A careful study of the surface of the diencephalon discloses a minute transparent area lying between two whitish streaks. The latter are transverse commissures in the roof of the third ventricle; the former is the cavity of the epiphysial tube, or recessus pinealis, the brain-cavity being separated from the pia mater only by a single layer of cells. This transparent area has already been pointed out by Goette[2] in the frog, where it is somewhat less conspicuous. In front of the foremost commissure is a triangular transparent space; at the sides of this are two horn-like forward continuations of the diencephalon. These processes I consider homologous with the habenulæ of the mammalian brain, and with the "Schnabelförmiger Fortsatz" described by Müller in the lamprey's brain. In the lamprey they coalesce in

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[1] The nomenclature proposed by Prof. Burt G. Wilder has been adopted, with few exceptions. It proceeds upon the consistent plan of naming the segments, and their various parts, as far as possible, after the segmental names which now meet with general acceptance among anatomists; also of using abbreviated forms of the longer terms now in use. For the sake of clearness the new terms, and their synonyms, which are employed in this paper are given below. The *Prosencephalon*, including: the *procœliæ*, lateral ventricles; the *proplexi*, lateral plexuses; the *prosocœlia*, ventriculus communis laborum; the *supraplexus*, plexus in the roof of the prosocœlia; the *porta*, foramen of Munro; the *terma*, lamina terminalis; the *præcommissura*, anterior commissure. The *Diencephalon*, including: the *supracommissura*, commissura habenarum; the *processus* and *recessus pinealis*, the *postcommissura*, posterior commissure; the *diacœlia*, third ventricle. The *Mesencephalon*, including: the *mesocœlia*, iter, etc. A system of this kind must undergo modification, from time to time, but in the end it will be far superior to the present cumbersome multinomial system.

[2] Entwickelungsgeschichte der Unke, 1875.

the median line, but here they are separate, as may be seen by a close external examination, and verified by transverse sections. This homology is confirmed by the study of the foremost of the transverse commissures. In front of this space rises the reddish body, which has been generally mistaken for the epiphysis. In the natural state this body is not very prominent, but as soon as the ventricles collapse, it is thrust conspicuously upwards. The ventricular collapse is also the occasion of an artificial dorsal furrow in the optic lobe, which is here absolutely unpaired. Upon the ventral aspect of the brain we again observe two transparent areas. One resembles a long slit in front of the optic chiasma, and is found to be a portion of the lamina terminalis. The other is due to a thinning of the floor of the infundibulum, and is seen immediately in front of the hypophysis. The hemispheres are closely applied to each other, but have no structural union. The cerebellum is slightly overhung by the optic lobe.

The proportions of the various segmental parts are very similar to those of *Menobranchus*, and this seems to accord with the similarity of the proportions in the head, body and limbs of these animals.

Internal Structure.

A natural introduction to the internal structure would be a description of the walls and cavities of the various segments, but it happens that the boundaries of these segments can only be determined after we settle upon the relations of the parts which compose them, so, until some of the details have been investigated, this description must be postponed. In general, the brain is a tube forking in front into the paired lobes and cavities of the hemispheres.

The Ependyma and Pia Mater.—The pia mater closely invests all the brain surfaces and sends numerous nutrient vessels into its walls. It envelops all parts of the brain, with the exception of the hypophysis, which lies external to it (fig. 4), so that the pia actually separates the hypophysis from the floor of the infundibulum and sends in numerous smaller vessels between the epithelial tubes which constitute this body. This relation is not true of the posterior lobe of the hypophysis which is a development of the brain-wall and is surrounded by the pia, the anterior lobe as is well known, arising from the oral epithelium.

At several points the pia and ependyma unite to form the sole elements of the brain-wall, giving the transparent effect, in external view, which has been mentioned. A striking instance of this is seen in the dorsal wall of the infundibular cavity, which is extremely delicate, the ependyma consisting of a single row of cells. The vascular plexuses above the medulla and between the hemispheres are instances of such union, elaborated by the introduction of vascular plexuses from the pia. Three varieties of the cells of the ependyma can be distinguished. The cells of the first variety form a general investment of the inner brain-wall; they are from one to three deep, cylindrical or much elongated, crowded between them are yellowish oily granules, and many of the cells remotely resemble ordinary fat cells in the possession of a proto-plasmic nucleated centre, lying between yellowish, unstained terminations. It is the innermost of these cells which give rise to thread-like processes which radiate outwards in the brain-wall, but the latter never make such beautiful displays as are seen in the frog's brain, and figured by Stieda.[1] The cells of the second variety lack the fatty granules; they are found coating the *præcommissura*, but are principally observed wherever the brain-wall is reduced to a single row of cells as in the roof of the infundibulum, and in that part of the floor to which the hypophysis is attached; they are small, rounded cells, at one point becoming very much elongated, namely, in the sides of the *processus pinealis*. The transition from this to the third variety is beautifully shown in the forward portion of the roof of the third ventricle. Here the rounded passes into the beaded character of the single cell layer which follows the elaborate foldings of the *diaplexus*.

The consecutive series of sections in three planes afford fine material for the study of the nerve-fibre courses, and much has already been ascertained that throws light upon the relations of the brain segments. I will here describe only the fibre courses which have a transverse direction, considering under this head the relations of the cerebellum,[2] the origin of the optic nerves, and the various commissures.

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[1] Zeitschrift für wiss. Zool., Band xx.

[2] Compare E. C. Spitzka. The relations of the Cerebellum, Alienist and Neurologist. New York, January, 1884.

The Cerebellum (figs. 6, 7).—Numerous as are the errors which at present prevail in the literature of the amphibian brain, none are more striking than those relating to the cerebellum.[1] It is said to retain its embryonic condition of a small band-like structure stretching over the fourth ventricle. Now it happens that the amphibian cerebellum is a flat structure, and if viewed on edge, as is the case in looking down upon the frog's brain, it does appear very small; if, on the other hand, it is seen in vertical longitudinal section, its large bulk, relatively to other parts, is at once apparent. If, further, as will be done in another paper, a corresponding section of an amphiumà brain be superposed upon the frog section, we find that the former barely covers one-twenty-fourth of the diameter of the latter, although the Amphiuma is a very much larger animal. The description referred to above, then, is as exaggerated when applied to the frog as it is true of such forms as *Amphiuma*, *Menopoma* and *Menobranchus*.

In *Amphiuma*, the cerebellum is reduced to its simplest possible expression. It seems doubtful whether it contains any nerve cells whatever. In *Menopoma*, however, a few cells similar to those in the optic lobes, can be observed on either side of the transverse fibres which make up the larger part of this body; it is difficult to distinguish these cells from those of the ependyma. Notwithstanding the character of this body, its main relations to the adjoining parts are precisely similar to those of the higher vertebrates. These relations have already been indefinitely indicated by Stieda. (1.) From the lateral tips of the medulla arises a column of fibres on either side, which arches forward; here the columns are reinforced by fibres apparently arising from lateral cell-masses, these columns turn back and enter the cerebellum. (2.) Passing beneath these columns is another pair, which diverge and then converge as they enter the pars peduncularis of the mesencephalon; they can be followed some distance forwards upon either side of the mesocœlia. (3.) Passing directly forward from the ventral surface of the cerebellum, a few scattering fibres enter the valvula and with some doubt can be followed into the cells of the roof of the optic lobe. In one and two we recognize the post- and præ-pedunculi or inferior

[1] Mihalkovics, *loc. cit.*, p. 56; also, Wiedersheim, Lehrbuch der Vergleichenden Anatomie, 1883, p. 297.

and superior (processus ad cerebrum) peduncles of the higher vertebrate brain.

The scarcity, if not absence, of nerve cells in the Amphiuma or Menopoma cerebellum, renders it difficult to understand the meaning of these peduncles, unless we regard the cerebellum here as in large part a decussational system, composed of fibres crossing from one side of the brain to the other. It may be added that the frog's cerebellum is richly cellular.

The Optic Nerves (fig. 8).—No fibres have as yet been followed from the optic lobe (Mesencephalon) to enter the optic tracts, although there can be little doubt that they are present; but the fibres in the thalami arise in a manner which points, almost with certainty, to the important fact that in the Amphibia the *decussation of the optic tracts is incomplete.* In other words, part of the fibres of each optic nerve enter from the chiasma, *i. e.*, from the opposite side of the brain, part enter from the same side of the brain. (1.) The fibres supplying the chiasma, arise from cell masses in the upper lateral portions of the thalami, and sweep around the sides of the thalami, partly encircling the main longitudinal fibre system (crura cerebri); they pass downwards and obliquely forwards, enter the chiasma, and apparently pass to the nerve of the opposite side. (2.) In the floor and lower lateral cell masses of the thalami arise smaller bundles of fibres, which pass beneath the longitudinal system, above and then in front of the chiasma to enter the optic nerve of the same side. They can be traced by following successive sections forwards, but do not interdigitate with the fibres of the chiasma, as in the figure which combines the results of a series of sections. If this fact is confirmed by other observers, it will show that the partial decussation of the optic tracts is an early, if not a primitive condition, instead of being peculiar to the higher mammals, as has been generally maintained.

The Commissures.

The Præcommissura (fig. 9).—In the frog's brain [1] it has been found that there are two divisions of this commissure: a posterior, connecting the lower portions of the hemispheres, and an anterior, connecting the upper median walls. Both have been found in *Menopoma*, the latter arching upwards at the sides, and, as is clear in fig. 4, it forms on either side the posterior boundary of

[1] Stieda, *loc. cit.*, p. 308.

the porta, or passage from the single to the lateral cavities of the Prosencephalon. In *Menopoma*, however, the posterior division is immediately below the anterior, and it is found in the horizontal sections to be not a true commissural, but a decussational system. At this point, a large number of the fibres composing each of the longitudinal tracts, just mentioned in connection with the optic chiasma, cross each other and pass to or from the base of the opposite hemisphere. In *Menobranchus* these two tracts are completely separated, the upper division passing independently across the ventricle.

The Postcommissura.—Although this commissure is part of a conspicuous fold of the brain-roof separating the Dien- from the Mesencephalon, it really contains in the Amphibia but few fibres. Another interesting fact is that these fibres do not enter into the thalami, but pass obliquely backwards into the region of the longitudinal tracts composing the pars peduncularis of the Mesencephalon. This accords with Mihalkovics'[1] observations upon the chick, and tends to confirm Pawlowsky's[2] view that this is not a commissure in the strict application of the word, but is rather a side connection of the longitudinal fibre system. This view accords also with Ahlborn's recent observations upon the lamprey.

The Supracommissura (fig. 8).—In the forward portion of the roof of the diacœlia, and immediately above the optic chiasma is a commissure, which, as far as I can ascertain, has been heretofore entirely overlooked in the Amphibia. In *Menopoma* and *Amphiuma* it is very large; in the frog it is much reduced, and lies further forward; in *Menobranchus* it is represented by a slender band of fibres immediately in front of the *recessus pinealis.* In all these forms it lies in front of the epiphysial process, and completely separates this tube from the dia- and supraplexus. It occupies the same relative position as the variously named *Commissura habenarum*,[3] or the commissure of the pineal stalk (Mihalkovics)[4] of the mammalian brain, as well

[1] *Loc. cit.*, p. 73.

[2] Pawlowsky, Ueber den Faserverlauf in der hinteren Gehirncommissur. Zeits. für wiss. Zool., Band xxiv, 1874.

[3] Wilder, Anatomical Technology, 1882, p. 452.

[4] *Loc. cit.*, p. 100. This comparison is somewhat doubtful.

as the commissure figured by Professor Balfour[1] in the Elasmobranch brain. It passes across the posterior ends of the hook-like processes of the thalami, which I have compared with the habenulæ, and the most satisfactory interpretation of this commissure is afforded by a comparison with Ahlborn's figures of the lamprey brain.[2] At the sides and to the front of the *recessus pinealis*, I find in *Menopoma* two compact masses of nerve cells, which I think we may compare with the *ganglia habenarum*. These masses form the posterior, and to some extent the inferior, boundary of the *supracommissura*. Following the fibres of this commissure downwards and forwards, we find that they partly enter the thalami, while the greater part pass directly into the hemispheres. Their distribution, then, is similar to that of the fibres of the *tænia thalami optici*, while the commissural portion may be compared with a slender commissure, the *commissura tenuissima*, traversing the habenulæ in the lamprey's brain. The relations to the hemispheres are especially interesting, as they indicate, between the posterior parts of these bodies, a commissural union of considerable extent and importance.

Infundibular Commissures.—The lobes of the infundibulum are united dorsally and ventrally by two commissures, the uppermost being quite distinct and extensive (fig. 4) and forming the thin fold which divides the iter from the infundibular cavity.

THE HYPOPHYSIS AND EPIPHYSIS.

The backward extension of the *hypophysis*, together with its great development, and the unusual size of the infundibular cavity and lateral lobes, lend this portion of the brain especial interest. I will, however, only remark here upon the clear separation of the anterior and posterior lobes of the hypophysis, by the turning in of the pia mater over the forward face of the anterior lobe (fig. 4). The vessels of the pia ramify between the columnar epithelial cells, which compose the tubes forming this lobe. In vertical section the lumen of one of these tubes is occasionally seen. The ependyma is much convoluted in the posterior lobe, and these foldings may readily be mistaken for tubes.

Our knowledge of the *epiphysis* in the Amphibia is in a far from satisfactory state. There can be little doubt as to the correctness

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[1] Elasmobranch Fishes, plate xv. [2] *Loc. cit.*, p. 285.

of Goette's important observation[1] that in the batrachia the epiphysis proper loses its primitive connection with the brain, and lies external to the skull, while its primitive union with the brain is indicated by the more or less degenerate walls of the epiphysial tube. Yet Goette's figures do not give such a clear history of these changes, as the importance of the subject demands, and so far as we know, there have been no embryological investigations on this subject among the urodela.

In the meantime, since the publication of Goette's discovery, many general works[2] by different writers upon comparative anatomy have appeared, all of which figure the epiphysis as a conspicuous object lying between the cerebral hemispheres. There can be little doubt that these, as well as all the earlier writers upon the Amphibian brain, such as Wyman, Ecker, Leidig, Rathke and Stieda have mistaken the remarkable upgrowth of the vascular plexus above the prosocœlia for the epiphysis, and that this body in the urodela, as well as in the batrachia, is represented upon the brain surface merely by a portion of its primitive stalk. The grounds for this statement, so far as it concerns the urodela, are that in *Amphiuma*, *Menobranchus* and *Menopoma* portions of this primitive stalk can be seen in vertical section, in different stages of arrest, and retaining to a greater or less extent the primitive condition of a glovefinger-like upfolding of the brain roof.

In the discovery of the supracommissura and the invariable position of the recessus pinealis, between this and the postcommissura, we find unmistakable anatomical evidence for Goette's conclusions, although we are not thereby warranted in assuming that the development of the epiphysis is the same in the urodela as in the batrachia. All doubt is also removed as to the connection between the stalk of the epiphysis and the supraplexus, as the latter is clearly distinct from the former, and does not establish such close relations with the stalk as in the birds.

In *Menopoma* (fig. 4) the ependyma cells upon either side of the recessus become much enlarged and elongated; upon the upper surface of the brain they lose this character, becoming

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[1] Entwickelungsgeschichte der Unke, 1875, p. 283.

[2] Huxley and Martin's Practical Biology, Wiedersheim's Lehrbuch der vergleichenden Anatomie and Wilder's Anatomical Technology may be cited as examples.

small and spherical, and folding over, form a single-layered much flattened sac, the lumen of which retains its connection with the diacœlia by a narrow slit. This is the only adult trace of the *processus pinealis* in *Menopoma*. In *Rana* (fig. 5) I find the same elongation of the ependyma cells, and similar cells forming the processus, but in a double row. Here the supracommissura is much smaller, and more widely separated from the postcommissura, this interval is bridged by a delicate single row of cells which appear to turn up and form the anterior border of the recessus, although this point is not very clear. There is also some doubt whether the lumen of the processus retains its communication with the diacœlia. The processus itself is a long, flattened, two-layered sac, circular in section, extending anteriorly so as to overlap the supracommissura. The pia mater overlaps the processus upon all sides, indicating that it primitively was directed upwards. Extending from above the *postcommissura*, forwards to the base of the epiphysial stalk, are numerous fibres, which appear to enter into relations with the cells of the stalk. In *Menobranchus* and *Amphiuma* we find a nearer approach to the frog than to the *Menopoma* condition, the processus forming an elongated flattened sac, completely constricted off from the brain cavity.

The Plexi choroidei.—There is a singularly simple and beautiful display of the relations of the intra-ventricular blood-vessels in the brain of *Menopoma* (fig. 4). The thrusting in of the ependyma extends from the supracommissura to the upper portion of the terma. The arterial supply is apparently derived from the median arteria carotis cerebralis, and the venous return is at the sides of the supraplexus. The division into supra-, dia- and proplexus is a somewhat artificial one here, but is not so when applied to the Amphiuma brain, where the supraplexus is very prominent, and the diaplexus extends well back into the Mesencephalon. The lateral wings of the diaplexus are shown passing through the porta in fig. 9. The nature of the ependyma cell-lining of these vessels is very constant; small and large, the cells have the same elongated, bead-like appearance.

The Encephalic Segments.—Stieda,[1] following general usage, considers that portion of the median brain-floor lying behind the

[1] *Loc. cit.*

chiasma as the lamina cinerea, that lying in front, as the lamina terminalis. This construction cannot be applied here with accuracy, owing to the unusual position of the praecommissura, in the brain-floor, instead of in the anterior median wall. Yet for comparative purposes it is best to retain this interpretation. It gives us an unusually extended prosocoelia, or ventriculus communis laterum, which we find is a distinctive feature also of the Amphiuma and Menobranchus brain. The supracommissura may be considered as the upper posterior boundary of the prosocoelia, separating it arbitrarily from the diacoelia, as the postcommissura does the dia- from the mesocoelia. At all events, the supraplexus clearly belongs to this cavity rather than to the diacoelia.

The general subject must be discontinued here, to be resumed in connection with the brain of the Menobranchus, in a subsequent paper.

Morphological Laboratory, Princeton, *Oct. 20, 1884.*

EXPLANATION OF PLATE VI.

Illustrating the Brains of Menopoma and Rana.

Encephalic segments Rh.—Rhinencephalon; *Pr.*—Prosencephalon; *Di.*—Diencephalon: *Ms.*—Mesencephalon; *Ep.*—Epencephalon; *Met.*—Metencephalon.

General Abbreviations.

a.—Prosocoelia, cavity of the primitive prosencephalon.
a. hph.—Anterior lobe of hypophysis.
a c c.—Branch of *Arteria carotis cerebralis.*
cbl.—Cerebellum.
ch.—Optic chiasma.
cn. cs.—Canalis centralis.
dc.—Diacoelia, third ventricle.
dpx.—Diaplexus, choroid plexus of the third ventricle.
end.—Ependyma.
h.—Habenula.
hem. and *hem'.*—Section and external surface of right hemisphere.
hph.—Hypophysis.
i. cm.—Inferior commissure of infundibulum.
l.—Longitudinal fibre courses, cut transversely.
med.—Medulla oblongata.
msc.—Mesocoelia, iter.
mtc.—Metacoelia, fourth ventricle.
mtpx.—Metaplexus, *tela vasculosa* of the fourth ventricle.
my.—Myelon, spinal cord.

opt.—Optic lobe.
p.—Porta, Foramen of Munro.
pcs.—Postcommissura, posterior commissure.
p. hph.—Posterior lobe of hypophysis.
pi.—Pia, pia mater.
ppd.—Post-pedunculus, posterior peduncle of cerebellum.
pp.—Pars peduncularis of Mesencephalon.
prs.—Procœlia, lateral ventricle.
pr. cs. and *pr. cs'.*—Præcommissura, anterior commissure, lower and upper divisions.
pr. eph.—Processus pinealis, the epiphysial stalk.
pr. px.—Proplexus, the choroid plexus of the lateral ventricle.
pr. pd.—Præpedunculus, anterior peduncle of cerebellum.
r. eph.—Recessus infra-pinealis, the opening of the epiphysial cavity into the diacœlia.
rhs.—Section of olfactory lobe.
rst.—Restiform tract.
sa.—Supracommissura, commissure of the habenulæ.
sm.—Superior commissure of the infundibulum.
spx.—Supraplexus (formerly considered the epiphysis), the upper portion of the vascular plexus of the prosocœlia.
spd.—Supra-pedunculus, fibres passing from the cerebellum into the optic lobe.
t.—Terma, lamina terminalis.

FIGURES 1, 2, 3. Dorsal, ventral and lateral aspects of the brain of *Menopoma Alleghense*, enlarged five diameters. The whitish band stretching across the infundibulum, in front of the hypophysis, probably consists of the inferior infundibular commissure. In the dorsal aspect of the fresh brain, the position of the epiphysial process, is marked by an oval transparent area, in front and behind which, the supra- and post-commissuræ shine through. This area is undoubtedly contracted by reagents. The natural backward direction of the cerebellum is also altered, so that it hangs beneath the optic lobe.

FIGURE 4. Longitudinal vertical section of the brain of Menopoma, in a median plane as far forwards as the terma, and in front of this through the centre of the right hemisphere; enlarged sixteen diameters. The dotted ellipse indicates the position of the porta, or foramen of Munro.

FIGURE 5. The diatela, or roof of the third ventricle of the brain of *Rana fugiens*. This figure represents the long tubular epiphysial process, composed of two or three rows of cells, mostly enveloped by the pia and extending forwards above the supracommissura. The inner layer cells send short processes into the persistent cavity of the epiphysis, and the cavity is filled by a highly transparent meshwork, which may simply consist of coagulated fluid. The opening into the diacœlia, *r. eph.*, is doubtful. The lines (*fl.*), indicate a number of nerve fibres, which apparently extend to the base of the epiphysial process.

FIGURES 6–9 are of *Menopoma.*

FIGURE 6. A composite of three transverse sections through the cerebellum and medulla.

FIGURE 7. Diagrammatic representation of the nerve fibre courses springing from the cerebellum.

FIGURE 8. A composite of six sections through the diencephalon, showing the course of the fibres of the supracommissura, and probable origin of the optic tracts. *a–a′*, supposed course of fibres passing from upper parts of thalamus to optic nerve of opposite side. *b–b′*, course of fibres from lower parts of thalamus to optic nerve of same side.

FIGURE 9. An oblique section through the region of the præcommissura, showing the distributions of the fibres of this commissure, also the supraplexus, the proplexus, and porta. The right side is cut anterior to the left.

ON THE CUSPIDIFORM PETROGLYPHS, OR SO-CALLED BIRD-TRACK ROCK-SCULPTURES, OF OHIO.

BY DR. D. G. BRINTON.

In the study of American rock-sculptures, the attention of archæologists has several times been drawn to a peculiar character which appears frequently on the inscribed rocks of central and northern Ohio, and rarely, or not at all, outside of this region.

It has been called a bird-track or specifically, a turkey-track, and has been supposed to be a conventional representation of the impression of the foot of this or some other bird. A recent study of one of the best examples of it, near Newark, Ohio, has led me to a different opinion as to its significance, and I take the occasion to explain this, and also to offer some suggestions as to the distribution and purport of this design.

In Ohio, rocks bearing this figure are found near Barnesville, Belmont Co.; near Amherst, Lorain Co.; at Independence, Cuyahoga Co.; in Licking Co., and elsewhere. It does not occur in the rather numerous inscriptions upon the Ohio River, nor in those south of that stream. Nor has it been reported in the various petroglyphs existing in the Susquehanna Valley and in New England. In fact, it seems confined pretty closely to that area which was occupied by that people whom we call, for want of a better name, the mound-builders. This adds interest to the investigation of the character and its meaning.

That it possessed some definite signification would seem to be demonstrated by the frequency of its recurrence and the regularity shown in its tracings; this indicating that it was a familiar figure, and that constant repetition had conferred on the designer a certain technical skill in forming it. This would not be the case were it merely the product of an idle hand, and of no import.

As I have said, this peculiar figure does not occur in other American rock-inscriptions. It is, indeed, very rare in any other locality. Dr. Richard Andree, in his "*Ethnographische Parallelen*" (Stuttgart, 1878), gives drawings of fifty-nine rock inscriptions from various parts of the world, but on examining them I find only one which presents any analogy to that under considera-

tion; that one is from Somal Land, in Africa, ten degrees north of the equator.

There are, however, some very ancient Chinese inscriptions, dating from about the fourth century before our era, which show a similar device. For this reason, Dr. J. F. Salisbury, of Ohio, has maintained that some connection existed between the mound-builders and the ancient Chinese.

My own opinion, based on a close inspection of the inscribed rock in Licking Co., Ohio, is that the so-called bird-tracks were never intended to represent the footprints of any species of birds, but are conventional signs for *arrows* or *arrow-heads*. My reasons are the following:

In no case are there representations of toes or claws. The centre line is frequently prolonged, passing beyond the junction of the lateral lines, thus giving to the figure a cruciform appearance. More often it is prolonged in the other direction—sometimes to three or four times the length of the lateral lines—presenting an unmistakable picture of a barbed arrow-head on a shaft.

The lateral lines are usually three or four inches in length, while the median line is always longer. The incisions are clean and clear, the edges sharp and singularly firm, betraying a practiced hand and a powerful instrument.

On the supposition that these are intended for arrow-points, I propose for them the name of "cuspidiform petroglyphs." This is descriptive of their actual appearance, and also indicates what they were doubtless designed to represent.

Granting this, we do not have to go far to ascertain the idea which this sign was intended to convey. There can be little doubt but that the arrow signifies a warrior, or some related military conception.

This, in turn, throws light on other points in the archæology of the Ohio region. The inscribed rock at Newark is within about eight miles of a very remarkable series of works between the north fork of Licking River and Raccoon Creek. One of these works is a mighty circular embankment, enclosing an area of thirty acres, now used as the fair grounds of Licking Co. In the midst of this area, headed toward the only entrance, is an effigy mound, of large size, commonly supposed to represent an eagle. At present, however, the alleged eagle has no head, and I could

not see signs that it ever had had one. The figure is, indeed, nothing else than one of these cuspidiform symbols on a gigantic scale. It measures along the central elevation 210 feet, while the lateral lines, called the "wings," branch off about 100 feet from the limits of the central ridge. The point of the arrow is directed precisely to the single gateway or opening of the enclosure.

The inference which the presence of this gigantic delineation of an arrow-head seems to justify, is that this enclosure was once dedicated to military ceremonies of some kind.

The inscribed rock on which my observations were made, is located about six miles from Newark, close to the bank of the Licking River. It is a moderately hard sandstone, much eroded where fully exposed to the weather. The bluff is about thirty feet high, and the summit overhangs the base to such an extent that it furnishes a natural shelter. Many of the inscriptions have thus been preserved with great freshness of outline.

This rock shelter was also extensively used by generations of primitive hunters. Excavations which I made, turned up numerous examples of their work in pottery and stone, and the fragments of the bones of animals used in their repasts.

The only previous examination of this inscription, for archæological purposes, which I have heard of, is one by Dr. Salisbury, in 1859, the notes of which are in MS., in the library of the American Antiquarian Society. A brief memorandum by him, on the subject, was also published in the Report of the Ohio centennial managers in 1876.

NOVEMBER 4.

The President, Dr. LEIDY, in the chair.

Twenty-one persons present.

A paper entitled "On the Behavior of Petrolatum in the Digestive Tract," by N. A. Randolph, M. D., was presented for publication.

Impression of the Figures on a "Meday Stick."—Dr. D. G. BRINTON exhibited a full-sized impression of the figures on a "Meday Stick," obtained from the Pottawattomies, by the eminent antiquary, Dr. E. H. Davis.

These sticks are used as mnemonic aids in repeating the chants in the "Great Medicine Lodge," the principal religious rite of the Algonkins. The present stick is 19 inches long, 2¾ inches wide, and of hard wood. The figures engraved upon it are over 500 in number, chiefly representing plants. These figures are engraved with a knife, but the native name of such sticks points to a more primitive method. It is *massinahican*, literally "a piece of wood marked with fire." The characters inscribed are called *kekiwin*, which means *marks* or *signs*, and from which root are derived the words "to know," "to learn," and "to teach," in many Algonkin dialects.

The characters are of two kinds, notches, and drawings of objects. The notches are believed to indicate the musical time or rhythm of the chant, while the drawings suggest its words. The text of several such songs has been printed. They are usually to obtain success in the chase or restoration to health. The latter appears to be the nature of the present song, judging from the numerous plants depicted.

This Meday stick illustrates an instructive fact constantly lost sight of by antiquaries. The so-called picture-writing of the Algonkin Indians never presented pictures. There is no grouping, shading or pictorial arrangement of the figures. There is no attempt at esthetic effect. The single figures are not connected so as to evoke any artistic sentiment. The intention was wholly apart from this, and where such appears, it is not true Algonkin art.

NOVEMBER 11.

Mr. JOHN H. REDFIELD in the chair.

Thirty-two persons present.

The following papers were presented for publication:—

"Descriptions of New Species of North American Heterocera," by Herman Strecker.

"Some Notes on the Movements of the Andrœcium in Sunflowers," by Dr. Asa Gray.

"Observations on Cinna, with Description of a New Species," by F. Lamson Scribner.

Fired Stones and Prehistoric Implements.—Dr. D. G. Brinton exhibited specimens of quartzite, sandstone and jasper, which had been subjected to the action of fire, and spoke of their bearing on certain archæological questions.

The most ancient evidence of a knowledge of fire is not the charcoal and ashes of primeval hearths, but stones showing the action of the element. In France they have been found in considerable numbers in the tertiary deposits of Thenay, near Pontlevoy, belonging to the late miocene or early pliocene. In South America, the brothers José and Fiorentino Ameghino have discovered them in a low stratum of the Pampas formation, believed to be referable to the interglacial epoch of the pleistocene.

The effects of fire on stones are quite distinct from those of other agents. They are shown in discoloration, scaling, and peculiar forms of fracture. Quartz becomes cloudy and opaque; jasper loses its fresh yellow hue to turn a dull red, while sandstone forfeits the fresh lustre of its fracture, and shows brown and blackish.

Stones broken by fire present one of two characteristic appearances; the one is called by French archæologists *Craquellage*, the other *Étonnement*. Quartzite illustrates the former, jasper the latter. *Craquellage* presents a plane usually at about right-angles to the plane of cleavage; its surface rough, friable, and full of little pits and rounded eminences—like a face pitted with small-pox, to borrow the simile of Mortillet. *Étonnement* is a splitting by flakes in the lines of percussion cleavage, but distinguishable from the latter by the absence of the bulb of percussion, and the splintering which often attends a blow. The flake and its matrix are perfectly clean at all points of their edges.

Scaling is seen on the surface of sandstones subjected to fire. Small scales are loosened and are detached by exposure, revealing the discolored layers beneath.

It is claimed by some of the French archæologists that the very oldest implements used by man were stones thus fractured by fire. This plan of bringing them to an edge, they say, preceded that of percussion. This does not appear to be the case in America. The implements of the Trenton gravels are of sandstone chiefly; those of the interglacial of the upper Mississippi are of quartzite, neither of which fractures by *Étonnement*. Whether the later residents of our soil ever used fire to aid their

art-production in flint and jasper is uncertain. The speaker had seen no specimens that conclusively showed that they did.

Cutaneous Absorption of Nicotine.—Dr. N. A. Randolph described the results of a series of experiments performed by Mr. Samuel G. Dixon and himself, relative to the absorption of nicotine by the uninjured healthy skin of the living rabbit. In these experiments only rabbits of ascertained good health were used. The fur of the abdomen was carefully clipped (not shaved); sufficient time, usually seven days, being allowed to intervene between this operation and the application of the drug to the skin; thus permitting any slight scratch made at this time to fully heal. The absence of cutaneous lesion was further confirmed by close examination under a strong hand-magnifier. The drug was then applied to the skin, no friction being used. In order to preclude the possibility of its vaporization and subsequent absorption by the lung surface, the nicotine was placed upon an adhesive plaster, the backing of which was made of sheet rubber. The plaster, with the drug in its centre, was then applied in the open air, on a windy day. Different doses were applied; thus, in one case, one drop of nicotine applied to the skin, caused death in five hours and eleven minutes. In each of three cases a similar application of ten drops was fatal in respectively one hundred and nine minutes, twenty-eight minutes, and thirty-six minutes. In the fifth case, a similar application of fifteen drops of nicotine caused death in twenty-eight minutes.

Of the ante-mortem symptoms, contraction of the pupil was *constant*, and often appeared very quickly. Other prominent symptoms were great trembling, with subsequent loss of muscular power in the extremities. In one case, actual convulsions were noted, and in others, coldness of the skin and increased lachrymal and nasal secretion. Immediately upon the death of two of the animals (after the ten- and fifteen-drop doses respectively), blood was removed, defibrinated, and tested with mercuric chloride for the presence of nicotine in the manner detailed by Wormley ("Micro-Chemistry of Poisons"). In each of these two instances, characteristic groups of crystals were found upon microscopic examination of the extract from the blood.

The following was ordered to be printed:—

ON THE BEHAVIOR OF PETROLATUM IN THE DIGESTIVE TRACT.

BY N. A. RANDOLPH, M. D.

The mixture of hydrocarbons, recognized by the pharmacist under the name of petrolatum, and popularly used under the commercial names of cosmoline or vaseline, presents on superficial inspection few points of difference from some of the organic fats of the same consistency. Close examination reveals differences, both in physical properties and in chemical constitution, between the bodies just compared. One point of difference, which I have as yet been unable to find recorded, lies in the respective behavior of these two groups, when in contact with the absorbent surfaces of the digestive tract. Thus, while the organic fats, as ordinarily taken in food, are readily and almost completely absorbed, this soft paraffin is entirely rejected, and found unchanged in the feces.

During eight days, I took daily one-half ounce of commercial vaseline, in addition to my regular diet. Digestion was in no wise altered, and no appreciable results ensued. Later, two healthy adults each received, in the course of forty-eight hours, one ounce of vaseline. Their alvine dejections for three days from the beginning of this observation were collected and dried, and, at the suggestion of Dr. John Marshall, of the University of Pennsylvania, extracted with petroleum ether. Making a slight allowance for incompleteness in extraction, the vaseline ingested was, in each case, recovered in its totality, showing that it had passed through the economy unchanged and unabsorbed.

There are some important medical applications of these facts, the discussion of which would be out of place here, and which I reserve for further experiment; but the following deductions appear permissible, and are of strictly biological interest.

I. Pure petrolatum, while entirely unirritating to the digestive tract, is valueless as a food-stuff.

II. The results of the experiments here described lend support to the theory that oleaginous matters are dependent, for their absorption, not upon mechanical, but upon vital activities, and that in such absorption the selective power of the protoplasm of the intestinal epithelium is manifested.

NOVEMBER 18.

The President, Dr. LEIDY, in the chair.

Thirty-seven persons present.

The deaths of Eli K. Price, C. P. Bayard and J. Edwards Farnum, members, were announced.

Urnatella gracilis.—Prof. LEIDY remarked that Mr. E. Potts had given to him, in October, 1883, a fragment of a tree-branch on which were many groups of *Urnatella*. The fragment, three inches by one-third of an inch, was obtained in the fore-bay at Fairmount. Around its middle, for about an inch in length, there were thirty separate groups of *Urnatella*, in nearly all consisting each of two stems, of unequal length, and devoid of terminal polyps. The stems diverged and curved downward and were quiescent, but were evidently living, as they exhibited slight sensitiveness to disturbance. The specimen was placed in an aquarium, exposed to the north light of a window, and in this position, at the moderate temperature of usual living-rooms, was kept during the winter. In March the stems were observed all to have developed polyps at the distal end, in which condition they continue at the present time (April). Most stems are terminated by a single polyp, but a few exhibit a smaller polyp, supported on a cylindrical joint springing from the antepenultimate joint of the stem, including the terminal polyp. The stems are quite irritable and bend in graceful curves from each other on the slightest disturbance. The longer stems even hang their heads in a single spiral turn. The longest stems consist of a dozen joints and measure about the one-eighth of an inch. The shortest stems exhibit one-third the number of joints. The stems appear alternately white and black, the former color corresponding with the thicker portion of the joints, the latter with the constricted portions. Many of the mature joints exhibit traces of the cup-like remains of attachment of branches, in most cases on one side only.

These specimens appear to indicate that, as in the other fresh-water polyzoa, the polyps die on the approach of winter, but the headless stems appear to remain, securely anchored, and ready to reproduce the polyps in the spring. If portions of the stems are destroyed, the remaining joints are capable of reproducing the polyps, commonly from the summit of the terminal joint. Branches usually spring from the last one or two joints, newly produced from that which immediately supports the terminal polyp. Specimens also show that heads may start laterally from old or mature joints. Thus the latter appear to serve as the statoblasts of other fresh-water polyzoa, but ordinarily they do not become isolated from one another. As no specimens have been seen with stems consisting of more than a dozen joints, perhaps after reaching this condition, the polyps become detached, to establish new groups.

The following were ordered to be printed ;—

DESCRIPTIONS OF NEW SPECIES OF NORTH AMERICAN HETEROCERA.

BY HERMAN STRECKER.

Smerinthus astarte.

♂ expands 3 inches; head brown; thorax above dark brown, patagiæ whitish gray; abdomen grayish brown above, more ashen beneath.

Primaries dentated exteriorly, but not as deeply notched as in *Cerysii*, but more so than *Opthalmicus*. Pointed apically more as in the latter, not so squarely cut off as in *Cerysii*. Secondaries larger in proportion and more evenly cut on outer edge.

Upper surface. Ground-color whitish gray, variegated with brownish shades and bands as in *Cerysii* and *Opthalmicus*, not as much broken and zigzag as in the first, neither as clearly defined as in the last; the white discal lune and accompanying line, extending half way along the median nervure, are boldly defined, as in *Cerysii*.

Secondaries rosy with white at inner margin, grayish at costa and inclined to brownish at exterior margin. An anal ocellus black, with a bisected blue ring enclosing large black centre. Fringe white.

Under surface resembles closely that of the two allied species alluded to.

Taken, in several examples, by Mr. David Bruce, near Denver, Colorado.

This remarkable insect, whether a good species or a variety of *Opthalmicus* or *Cerysii*, it seems impossible to determine; geographically considered one might be led to the conclusion that it was a link between the two, and to compare it placed aside of examples of either it is an impossibility to decide to which it belongs; the strongest point (and not a very strong one either) is the bisected blue ring of the anal ocellus, which would denote a closer affinity to *Cerysii*. Were it a hybrid, the product of the aforementioned two species it could not be more difficult to draw the line of separation, or to say to which species (or form?) it was most closely allied. Future captures in various localities may eventually lead to the knowledge that all three, *Opthalmicus*, *Astarte* and *Cerysii* are but forms of one species: to which belief I am most strongly inclined at the present writing.

Hepantheria cæca.

♂ expands $1\frac{5}{8}$ inches; head white above, black in front and

beneath; collar white, with two black lines or marks; patagiæ white, with a black band; thorax above white with a black central band from collar to abdomen; abdomen above whitish near the thorax, rest blackish, beneath white, a row of four or five (body a little abraded at sides) black spots laterally, and five ventrally; legs black, furred inwardly with white.

Primaries, upper surface, white with black spots, arranged much in the same order and number as in *Scribonia*, but instead of being circular or oval as in that species, they are parallelogrammic, square or wedge-shaped, and are not black rings encircling a white spot, but are all black blind eyes.

Secondaries white with some scattered brown marks at outer margin, heaviest near apical angle, and a brown discal spot.

Hab.—Colorado.

There is on this species none of the blue sheen so conspicuous on *Scribonia*, but the marks are all black or brownish black, and the whole insect calls up the idea very strongly of *Arctia Spectabilis* Tausch., from Russia.

Spilosoma niobe.

Expands 1¼ inches; head white, palpi yellow, terminally black; thorax white; abdomen above white, with a row of five large dorsal spots, sides yellowish, with two rows of black spots; some allowance must be made for the description of the abdomen, as it was compressed and somewhat rubbed. Legs yellow, tarsi ringed with black and white. Antennæ wanting on the single example whence this description is drawn.

Upper surface. Primaries white, with all nervures and nervules heavily bordered on both sides with brown; this brown is not dark and is much of the color of coffee with a somewhat undue amount of milk in it, in some lights it has a slight bronzy appearance.

Secondaries white, the nervules on costal half of wing towards apex shaded with same brown as superiors, but not as heavily.

Under surface nearly as above.

One example taken in Florida, some years since, by Mr. A. Bolter, from whom I obtained it.

Harpyia albicoma.

♂ ♀ size and form of *Borealis*, *Bicuspis*, *Bifida*, etc. Head and collar pure white; thorax above dark gray and white; abdomen above gray heavily clothed with white hair. Body beneath white.

Primaries, upper surface white with a dark steel-gray band crossing the wing about one-third from base, this band is chevron-shaped, narrowest in the middle and widening to double its width towards the costal and interior margins; in some examples divided entirely in the middle. Interior to this band is a transverse row of four dots of same color, and a single dot on costal nervure near the shoulder. Between the outer and median space of wing are three irregular broken gray lines, the outermost of which on the costal half joined by a broad wedge-shaped gray mark. A dark discal dot and dark point at termination of nervules.

Secondaries white, dark discal mark and dark dot at end of each nervule.

Under surface white, with markings of upper side more or less faintly reproduced, and the addition of a gray transverse line across the middle of secondaries.

Described from examples taken, in summer of 1883, by Mr. David Bruce, in mountains of Colorado.

This species comes nearest to the European *Bicuspis* Bkh., in the latter the dark band and marks are much heavier and more decided, but their arrangement is nearly the same.

Mr. Bruce took, this last season, also in Colorado, examples of *Cinerea* Wlk., which do not differ from those taken in Pennsylvania, New Jersey and New York.

Lophopteryx elegans.

♂. Form of *Carmelita*, which appears to be its nearest ally. Expands 2 inches. Head fawn-color; thorax above slate-gray, abdomen fawn, shading into brown towards the thorax, beneath whitish.

Primaries chocolate-brown, darkest towards base and along the costa, and shading into ashen along the exterior margin, a streak or line of pure silvery white along submedian nervule, starting at base and extending one-third the length of the inner margin; the narrow space between this line and inner margin paler brown, inclining to ochre. Two short, dark, subapical longitudinal lines; exterior margin with a fine dark line.

Secondaries white, with dark anal patch cut with a fine white line, as in other species.

Under surface. Primaries hoary gray, with brownish on costa and broad indistinct submarginal shade of same color parallel

with the exterior margin. Secondaries white, edged with brown on costa, and on exterior margin near and at anal angle.

From one ♂ received from Mr. Fish, taken in the vicinity of Oldtown, in the State of Maine.

In the old collection of Trexler, which came into my possession about twenty years since, was an example, in poor condition, which I consider identical with the above; recently I have received several examples, males, from Mr. David Bruce, who took them in Colorado. These I can consider nothing more than a variety of the above; the only difference being in the color of head and primaries, which in Trexler's and these Colorado examples is of a slate-gray, and not brownish as in the Maine examples; to prevent, however, the misfortune of this variety being described as a new species, I would designate it as *L. Elegans* var. *Grisea.*

Lasiocampa gargamelle.

♂ ♀ in form and general resemblance allied to *L. Pini.*

♂ expands about 2¼ inches. Head and thorax brown, intermixed with gray; abdomen brown.

Primaries obscure grayish, caused by an admixture of white and brown hair and scales; the basal third darker and more brownish; there is a tolerably broad outer margin wherein the brownish shade also prevails, this is separated from the paler, more ashen median space by an irregular zigzag brown line; there are also faint indications of two lines crossing the wing, one subbasal and grayish, the other half-way between the discal spot and the brown zigzag line, and scarcely perceptible; discal spot small, round and pure white.

Secondaries brown, with a paler, somewhat ochraceous mesial band, fringe white.

Under surface. All wings brown, with a common, rather broad pale, ochraceous median band.

♀ expands 3¼–3½ inches. Color has more of the brownish pre vailing. Character of the markings as in male, but less strongl defined; the median band of secondaries above, and all band beneath, narrower than in the other sex.

Hab.—Arizona.

By American authors this insect would be placed in Packar genus *Gloveria*, the type of which was *Gloveria Arizonensis;* th is, however, nothing by which it can be separated from *La campo* Latr. (*Gastropacha* O.).

NOTES ON THE MOVEMENTS OF THE ANDRŒCIUM IN SUNFLOWERS.

BY DR. ASA GRAY.

My attention was called to this subject by some observations made by Professor Meehan, the substance of which is now printed in the "Proceedings of the Academy of Natural Sciences," pp. 200, 201, under date of July 15 of this year. My own study of the subject was necessarily desultory and interrupted, and mainly too late in the season for the most satisfactory investigation. My object in sending this communication to the Academy, at this time, is, in the first place, to thank Mr. Meehan for calling attention to a very obvious fact, which I had entirely overlooked, and which those botanists (such as the late Hermann Müller), who have particularly attended to the adaptations for fertilization in Compositæ, were seemingly not aware of. The fact referred to, is the retraction of the anther-tube in *Helianthus* (and so, presumably, in its near allies), somewhat in the manner of *Centaurea* and the Thistle tribe generally. In the second place, I wish to maintain that this retraction in the sunflower is the result of automatic or irritable shortening of the filaments, and not of the "elasticity of the filaments." In other words, that those organs act in Sunflowers as they have for a long time been known to do in the Thistle tribe, but with some difference. If I rightly understand Professor Meehan's account, he supposes that the anther-tube is carried up to its full height by the elongation of the style within, its stigmatic apex pushing against the conniving anther-appendages which close the orifice of the tube, and so stretching the filaments; and that the elastic shortening of the filaments pulls down the anther-tube when the style has overcome this obstacle and protruded. If this were so, the stamen-tube should be drawn down at once upon overcoming the resistance. It is easy to test this, by snipping off the anther-tips by sharp scissors. But when I did this, no retraction followed. Moreover, on splitting down anther-tubes at various stages of their growth, I found that only at the last, and after the anther-tube had attained its full height, was the tip of the style in contact with the anther-tips. Prof. Meehan's idea that "the extension of the staminal tube is evidently mechanical, and is due solely to the upward growth of the stigma, which, partly it seems by the incurved points of the stamens, and partly perhaps by the expansion of the arms of the

pistil, is able to carry up the tube with it," so that when the resistance is removed, "the elastic stamens [filaments] draw the tube down again," must therefore be given up. The expansion of the arms of the style is not concerned in the process, for this does not commence until after complete protrusion.

As the filaments in the Thistle tribe are sensitive to the touch, in some Centaureas strikingly so; as these are not stretched in *Centaurea*, but are usually bowed outwardly, and as they contract upon the touch of a bristle or of a visiting insect, the first question is whether the same may be the case, in some degree, in Sunflowers. My essays to determine this were made too late in the season to be decisive. But in some flowers, on touching two adjacent filaments with a bristle thrust into one side of the corolla, the column moved promptly toward that side, moving through fifteen or twenty minutes of arc, very much as it will in a *Centaurea*. I did not succeed in causing the five filaments to act together, so as to produce any observable retraction. That this retraction normally takes place without extraneous irritation, is certain, commencing and commonly being completed on the second day after full anthesis; and equally in flowers shielded from the visits of insects.

In Sunflower-heads taken into a room and kept from bees, the pollen, pushed out of the tube through the chinks between the anther-tips, or later borne on the brush of the (as yet) unopened style-branches, is borne aloft, exposed to the humblebees which in the garden freely visit them. Prof. Meehan states that "honey-gatherers seldom resort to them," but I find that in our grounds these were much the most frequent visitors. These were passing from head to head and from plant to plant, inserting their proboscis into the corolla-tubes in succession, beginning at the circumference with the older flowers having expanded and receptive stigmas, and proceeding to the pollen-loaded ones within. It is easy to see that pollen is abundantly transported from one head and one plant to another, and that it is carried from flowers which could not possibly be self-fertilized until the next day, and unlikely to be so then, to those the expanded stigmas of which are only then receptive. Prof. Meehan "may say emphatically that these arrangements favor self-fertilization," but that is not the conclusion which I should draw from his own illustrations any more than from my own.

OBSERVATIONS ON THE GENUS CINNA, WITH DESCRIPTION OF A NEW SPECIES.

BY F. LAMSON SCRIBNER.

Two species of *Cinna*,[1] common to the northern regions of both the old and the new world, have long been recognized. They are *C. arundinacea* L. and *C. pendula* Trin. The latter, the more common of the two, has been reduced to a variety of the first-named, by some authors; but, aside from a marked diversity in habit, there are important differences in the characters of the spikelets quite sufficient to warrant a specific distinction. In *C. arundinacea* the spikelets are larger, firmer in texture, more strongly scabrous, more prominently nerved and there is a decided inequality in the outer or empty glumes, while in *C. pendula* these glumes are equal or nearly so. In both the floret is stipitate, or raised on a short stalk above the insertion of the empty glumes; in other words, there is a slight elongation of the axis of the spikelet between the two empty glumes and the flowering glume. Mr. Bentham, in his "Notes on Gramineæ," states that in *C. arundinacea* there is frequently a continuation of the rhachilla in the form of a short naked pedicel behind the palea: a character, he adds, that he has never seen in *C. pendula*. In my own studies, I have found this prolongation of the rhachilla, a common, not constant, character in both species. I have observed it in the spikelets of *C. pendula* from Maine and from Oregon; in fact, my own observations would lead me to say that it appears more frequently in that species than in *C. arundinacea*.

In regard to the variations in these two species something may be said. *C. arundinacea* exhibits considerable diversity in the size and diffuseness of its panicle and the spikelets, which range from a little over two to nearly three lines in length, vary in color from pale green to dark purple, but those characters mentioned above as distinguishing this species from *C. pendula*, remain constant. There is greater variation of the panicle in *C. pendula*, and also in the size of the spikelets; these, however, never reach two lines in length, and, although the empty glumes

[1] *Cinna macroura* Kth. and other grasses that have been placed in this genus, are now referred to *Epicampes* or *Deyeuxia*.

differ considerably as to width, acuteness and in the presence or absence of the lateral nerves in the second one, they are always very nearly equal in length. In the here-proposed new variety—var. *glomerula*, from Washington Terr., Frank Tweedy, collector—the equal, one-nerved empty glumes are very narrow, acuminate-pointed and scarcely more than a line in length. The spikelets in this variety are arranged in dense clusters or glomerules along the extremities of the branches of the very diffuse panicle.

A species of *Cinna*—No. 6090 Bolander, N. 22 of the small collection—came into my hands for examination several years ago, and my note at that time was that it was distinct from *Cinna arundinacea*, var. *pendula*, of Gray's Manual, under which name it was distributed. The past season my attention was again called to this grass by seeing some notes upon it in Dr. Gray's Herbarium at Cambridge, made, if I remember rightly, by Mr. Bentham, suggesting the probability of its being a new species. After careful comparisons with *Cinna arundinacea* and *C. pendula*, I am convinced that this suggestion is correct, and propose that the species be named *Cinna Bolanderi*, recognizing the fact that Mr. Bolander, so far as I know, has alone collected it.

Cinna Bolanderi.

Spikelets two and a half lines long, empty glumes broadly lanceolate, the upper one three-nerved, subequal, as long as the floret, which is scarcely, if at all, stipitate; culm stout, seven feet high (in Bolander's specimen), smooth; sheathes strongly striate, the lower smooth, the upper ones scabrous. Leaves firm in texture, prominently striate and scabrous on both sides, those of the middle portion of the culm one to two feet long, and three-quarters of an inch wide, all gradually tapering to a sharp point. Panicle eighteen inches long, loose and widely spreading.

From the characters above cited, the following synopsis may be made of the species in the genus:

Empty glumes unequal.

Spikelets $2\frac{1}{4}$ to 3 lines long. *C. arundinacea* L. 1.

Empty glumes equal or nearly so.

Spikelet less than 2 lines long, floret stipitate.

C. pendula Trin. 2.

Spikelet more than 2 lines long, floret apparently sessile.

C. Bolanderi Scribn. 3.

EXPLANATION OF PLATE VII.

FIG. 1.—Spikelet of *Cinna pendula* Trin.

FIG. 2.—Same with empty glumes removed, and the elongated rhachilla behind the palea brought forward into view.

FIG. 3.—Spikelet of *C. pendula*, var. *glomerula*.

FIG. 4.—Spikelet of *C. Bolanderi* Scribn.

FIG. 5.—Same with empty glumes removed.

FIG. 6.—Spikelet of *C. arundinacea* L.

FIG. 7.—A larger spikelet of same.

FIG. 8.—A spikelet of *C. arundinacea* with empty glumes spread out, and the continuation of the rhachilla behind the palea brought into view.

FIG. 9.—Spikelet of *C. arundinacea*, empty glumes removed; *a*, the stipe.

NOVEMBER 25.

Rev. H. C. McCOOK, D. D., Vice-President, in the chair.

Forty-one persons present.

Embryology of Fulgur, etc.—Mr. JOHN FORD reported the finding of capsules of *Fulgur carica*, containing living embryos, near South Atlantic City, on November 16, 1884.

As he had already secured live specimens in December, 1883, and in each of the six months following, this would prove the deposition of capsules by the species mentioned during the largest part of the year, instead of in the spring months only, as was formerly supposed. Living embryos of *F. canaliculata* were also obtained monthly, during the same period.

About one-half of the original amount of albumen in those found on the 16th, had been utilized by the young mollusks; a somewhat reasonable indication that they were near the middle stage of embryotic growth.

In further support of this probability, it was noticed that the delicate cilia which characterize the animal in its earlier stages, were much shortened, and the shells less transparent.

On the other hand, the thin circular membranes upon the edges of the capsules, through which the matured embryos finally escape, were still unbroken, and in much the same condition as when first exposed; thus proving that the young mollusks were as yet unprepared for a new stage of existence.

Several other strings of capsules, including some of *F. canaliculata*, were secured on the same occasion, but exposure to the sun for a day or two, had killed the embryos.

At the same locality were discovered two species of living Pholades, *P. crispata* Linn. and *P. truncata* Say, also a fine colony of living *Littorina irrorata* Say; all of these species being new, it is believed, to that part of the coast.

It is probable that the billet of wood in which the Pholades were found, had drifted from some distant locality, as there do not appear to be any conditions favorable to their existence between Brigantine Inlet and Great Egg Harbor Bay.

In regard to the habitat of the Littorina there could be no doubt whatever, as they were present in large numbers, and in a flourishing condition, although dwelling literally upon the sand, instead of on broken rock or pieces of timber, where the species is usually found. It is southern in distribution, rarely occurring north of the mouth of Chesapeake Bay.

An Unfamiliar Rhizopod.—Mr. EDW. POTTS remarked that he had observed, upon a scale of mica schist about one square inch in surface, clipped from a stone picked up near the eastern margin

of the Schuylkill River above the Spring Garden Water Works, Philadelphia, a dozen or more rhizopods of varying sizes, apparently quite motionless, and, by direct illumination, resembling the familiar forms of *Actinophrys* or *Actinosphærium*.

When removed to a compressorium and examined by transmitted light, however, entirely different characteristics were discovered. An outer surface or test was composed of infinite numbers of minute, smooth, curved spicules, gathered somewhat irregularly into radial, acuminate, conical groups, giving to the mass very nearly the appearance of the seed-balls of the sweetgum tree, *Liquidamber styraciflua*. Within the cavity of this spicular envelope, was seen a spherical protoplasmic body, perhaps one-third of the diameter of the outer test, composed of a multitude of granuliferous cells and a single non-central nucleus. From this "body," many pseudopodal filaments were thrown out through the interstices amongst the spicules, in direct radial lines, to a distance exceeding the height of the spicular cones. They were not constant, however, and at intervals none could be discovered. To test the character of the spiculæ, one individual was treated with strong nitric acid and afterwards mounted in balsam. The protoplasmic body was of course destroyed, but the spicules remained, showing them to be, in all probability, composed of siliceous material.

The speaker was at first inclined to class this rhizopod with the genus *Acanthocystis*, but further examination convinced him that it was more probably allied to *Raphidiophrys*, and a still further examination of F. E. Schultze's papers on the Rhizopodæ warrants its complete identification with his *Raphidiophrys pallida*. In his recent monograph upon this subject, Professor Leidy has referred to this species his sketch of a single individual likewise collected, some years ago, in the Schuylkill River. These appear to be the only instances in which it has been identified on this continent. Its habit of lying close against a supporting surface, seldom or never freely swimming, easily distinguishes it from other familiar Heliozoans.

Note on the Intelligence of a Cricket parasitised by a Gordius.—Dr. HENRY C. MCCOOK said that some remarks upon the habits of the cricket published by him, had called forth an interesting communication from Mrs. C. W. Conger, of Groton, New York, the substance of which is as follows:—

"Some twenty-four years ago, my husband and myself took possession of a large old frame house on a farm which was a homestead for the largest, blackest, and most musical of the cricket kind. Early in the fall, I began to be annoyed by finding one or more hair snakes in the water-pail. Though I knew that there positively was nothing of the kind in the pail when it came in, yet a few minutes or an hour generally provided us with a more or less lively specimen. I had a horror of them, because

of the dread lest the children should imbibe one with their frequent nips of the water, so I sat down, one warm afternoon, to watch the pail, to try to learn how the snakes came. In about ten minutes I saw a particularly plethoric cricket mount upon the edge of the pail, and, after some uneasy movements, bring the tip of the abdomen just beneath the water, and, with a few violent throes, expel a black mass, which fell slowly through the water, and before it reached the bottom resolved itself into one of the worms. The cricket seemed exhausted by the horrid birth, and did not find strength to draw itself up on the edge of the pail for about eight minutes, and when it finally did so, it tumbled to the floor and crawled off in a very rheumatic manner. After this discovery, we used to amuse leisure hours by watching like operations until frost killed the crickets. I sometimes would crush large crickets, generally with the result that a tightly-coiled snake would be thrust out of a rupture just above the tip of the abdomen; but, whether the snake was not sufficiently developed, or because of its needing water rather than air to vitalize it, none of the snakes so produced showed any signs of life."

The water snake alluded to is, of course, a species of our common *Gordius*, the same probably as that described, a number of years ago, by our distinguished President, Prof. Jos. Leidy. The fact that this animal is parasitic within the grasshopper, the speaker had himself observed; it has been said also to be parasitic within spiders, and doubtless has for its host many of the orthopterous genera. The point of greatest interest in the letter, Dr. McCook thought, is the fact that the crickets had evidently learned that the parasite infesting them required the water in order to make its egress, and had deliberately sought the suitable place and assumed the proper position (by inserting the abdomen beneath the surface of the water), necessary to insure that egress. It is a curious physiological question: how did the cricket obtain this knowledge? And, the knowledge having been obtained, the cricket's subsequent behavior presents an interesting fact in the study of insect intelligence.

A New Parasitic Insect upon Spider Eggs.—Dr. McCook further stated that he had received, through Mr. F. M. Webster (October, 1884), from Oxford, Indiana, a parasitised spider cocoon (evidently of some saltigrade species), apparently that of *Attus audax*. The cocoon contained within the outer flossy case about eighty cells and a number of mature black hymenopterous insects, about one-eighth of an inch long. The cells were ovoid, gray, blackish at the closed end, probably from excretions of the enclosed larvæ. One end was cut open, showing where the insect had escaped. With the exception of a few hard, dried, yellowish brown examples, all the eggs of the spider had disappeared. The specimens were sent to Mr. L. O. Howard, of the Bureau of

Entomology, Department of Agriculture, Washington, D. C., who judged them, after a cursory examination, to be Proctotrupids, belonging to the sub-family Sceliominæ, and seeming to form an entirely new genus. Thus appears to be added one more to the parasitic enemies of our spider fauna.

Rufus Sargent and W. Henry Grant were elected members.

The following were elected correspondents:—John Ball, of London; William Carruthers, of London; Rud. Leuckart, of Leipzig; Anton Dohrn, of Naples; A. Grenacher, of Halle i. S.; Alex. Götte, of Rostock i. M.; and Ludwig Will, of Rostock i. M.

DECEMBER 2.

The President, Dr. JOS. LEIDY, in the chair.

Thirty persons present.

DECEMBER 9.

MR. J. H. REDFIELD in the chair.

Thirty-one persons present.

On Derivation in Pinus edulis and Pinus monophylla.—At the meeting of the Botanical Section, on December 8, Mr. THOMAS MEEHAN called attention to some dried specimens of *Pinus monophylla* on the table, which were received in a fresh condition, a few months ago, from Mrs. Lewers, of Franktown, Nevada. At that time the phyllodes which took the place of the real leaves, were all monophyllous. In drying, several had opened in some specimens, and others readily separated by a little aid, showing that the species might have been two-leaved, but for some inability in the early stages of development to separate them. This monophyllous species was closely allied to *Pinus edulis*, which was confined to the Rocky Mountains; the monophyllous species being the form that prevailed further west. But in a small tree of *P. edulis*, growing in a deep ravine in Queen Cañon, in the Rocky Mountains, he had found on the same tree monophyllous, diphyllous, and triphyllous phyllodes, and there could not possibly be any doubt that the species were of one origin. The case was one worthy of note, because it had been charged that there was no actual evidence of the truth of the doctrine of derivation. Generally when such evidences as these were offered, the objector was prepared to abandon his belief in the specific distinctness of the forms, rather than to grant that two distinct species had been developed from one parent, and even in the case of these species

there were some who regarded one as but a variety of the other. But there were other distinctions: The cones were not quite the same, and the seeds being very different in size and outline, so that one could readily separate the seeds if mixed together. There was in fact a whole series of distinctions, fully as great as we could find in many well-recognized species, and which fully entitled the two forms to full specific rank; though in the face of the evident facts that they are derivations of one original parentage. Indeed, it was well known that when a plant changed its character in one respect, it must do so in others; plants in some climates annual, would become perennial or suffrutescent in others. The cotton-plant was a familiar example. In such cases the foliage and other characters varied from those connected with the annual form, and from this fact some botanists had regarded *Gossypium herbaceum* and *Gossypium arboreum* as distinct species. In the case of these two species of *Pinus*, the one which could not develop its phyllodes with two separate individuals, would of necessity present some peculiarities in the scales of the cone, as these were, morphologically, but transformed phyllodes. Under morphological laws, that which affected the leaves ought to affect the carpels or other parts of fructification which were modified from them.

The true position of the species in development is that *Pinus edulis* had the highest rank. In raising both species from seed there was no difference whatever between the seedlings during the first season. In these young and delicate plants, true leaves were perfectly developed; these were flat, linear lanceolate, and of a deep glaucous hue. *Pinus edulis* assumed stout vigorous branches the second year; then the true leaves were suppressed, a portion only being adnate with the stem forming a sort of cushion, or as bud-scales, or bracts under the scales of the cone, from the axis of which the phyllodes—secondary leaves, or bundles of leaves of some authors—spring. In *Pinus monophylla* only a few branches made phyllodes the second year, and he had plants which were ten years old from the seed, which continued to bear branches with true leaves almost equally with those bearing phyllodia. The monophyllous branches were never as strong as those from *Pinus edulis*, and in ten years a plant of *Pinus edulis* would be double the size of *Pinus monophylla*. Assuming, as we might, that the two had one parentage, we saw that the one had less vigor of growth; it retained more of its juvenile characteristics, and retained them longer than the other; and it never reached the power of development that *Pinus edulis* had attained. We may say, with confidence, that *Pinus monophylla* sprung from the same parentage as *Pinus edulis*, and became permanently different throughout, being subjected to conditions unfavorable to a full development. It would appear that the soil and climate of Nevada were not favorable to the usual development of *Pinus edulis*, and hence, through the long course

of ages, the suppressed features that characterized full maturity in the original, became, under the law of heredity, permanent ones.

It was not often that we had such clear evidence of the unity of origin in two certainly distinct species, and as supporting the modern ideas of evolution, the case was worthy of being placed on record.

DECEMBER 16.

The President, Dr. Jos. LEIDY, in the chair.

Twenty-nine persons present.

A paper, entitled "Homologies of the Vertebrate Crystalline Lens," by Benjamin Sharp, M. D., was presented for publication.

The death of Robt. L. Weber, M. D., a member, was announced.

Immediate Influence of Pollen on Fruit.—Mr. THOMAS MEEHAN directed attention to an ear of Indian corn on the table, sent by Mr. Burnett Landreth, which had nearly all one side with brownish red grain, the other side creamy white, which was the normal color of the variety. Usually the intermixture of colors which occasionally occurred in an ear of corn, is attributed to cross-fertilization. It is apparent that this could not be the case in this instance. The whole solid block is colored, and, at the edge of the colored mass only half a grain would be colored in some instances. The coloring influence had evidently spread from some central point, quite independent of any single grain, and had spread from grain to grain through the receptacle, until the coloring material was exhausted. In cross-fertilization from the entangled position of the silk-like pistils, no such regularity of coloring in adjoining grains could occur. On reflection we may understand that at times color in corn must come from causes independent of cross-fertilization, as the departure in the first instance from one color must be from an innate power to vary in color, independently of any pollinating influence.

The facts are interesting as bearing on many problems as yet not wholly solved. Much has been said about the changes in nature being by slow modifications through long ages, but we have frequent instances of sudden leaps. There are no gradations between the colors of these grains. Again, it is in dispute how far cross-fertilization influences the seed. Generally, no immediate influence is conceded; we have to wait till the seed grows, and we can examine the new plant to ascertain the potency of the several parents. So far, corn has been the chief, and almost the only, evidence that the seed or its surroundings are immediately affected; but recently statements have been made that the receptacle in the strawberry—what we know in every-day life as the

strawberry—is similarly influenced. There are some varieties wholly pistillate, and it is claimed that when pollen is applied from other varieties, the resultant fruit is that of the male parent. It is of great practical importance that such a question should be decided by undoubted facts. Experience in other directions does not confirm these views.

The *Mitchella repens* is really a diœcious plant. Many years ago he found one plant with white berries, and removed some portion to his own grounds, where, isolated from others, it produces no fruit. In its native location it bears white berries freely, though the pollen is from the original scarlet-berried forms. Mr. Jackson Dawson had given him a similar case on Professor Sargent's grounds, where a white-berried *Prinos verticillatus* is produced, though it must have pollen from the original red-berried form. Other illustrations were referred to. To those who looked for regularity of rule in these cases, and in the light of the specimen of corn before the meeting, there might be a doubt whether the variation in corn, often attributed to cross-fertilization, may not, in some cases, result from an innate power to vary. It did not really follow that the rule should be uniform, for those who had experience in hybridizing knew how variable were the results, even from the seed of a single flower. Parkman had obtained, in lilies, seedlings so exactly like the female parent, that only for the remarkable form from the same seed-vessel, known as *Lilium Parkmani*, it might have been doubted if some mistake as to the use of foreign pollen had not been made. If so little influence could occasionally be found at a remote end of the line, we may reasonably look for an immediate influence at the nearer end in some exceptional cases. But there appeared to be no carefully conducted experiments on corn recorded anywhere, though the belief in the immediate influence of strange pollen is a reasonable one so far as general observation goes. It seemed, however, to him, with the specimen of innate variation in corn before us, more careful experiments with corn and other things are desirable.

December 23.

The President, Dr. Joseph Leidy, in the chair.

Thirty-two persons present.

The following papers were presented for publication:—

"On a Remarkable Exposure of Columnar Trap near Orange, N. J.," by Prof. Angelo Heilprin.

"Note on Some New Foraminifera from the Nummulitic Formation," by Prof. Angelo Heilprin.

"A Review of the American Species of Stromateidæ," by Morton W. Fordice.

A Glacial Pebble.—Dr. Daniel G. Brinton exhibited a supposed stone implement, obtained from the glacial drift in Butler County, Ohio, sent to him by its finder, for examination. He observed that, while there is no inherent improbability in such a discovery—as it is quite likely that man, or at least an implement-making animal, existed on this continent during the glacial epoch—this particular specimen does not offer convincing evidence that it is a work of art. It is a polished stone, resembling an axe. Both these facts are against it. The axe type appears late in the stone age, and nowhere, except in California, have geologists gone so far as to put the age of polished stone so far back in time as the tertiary period. In that enterprising State, the men of science claim that, not merely fine, but the very finest, examples of polished stone ever found in either continent are exhumed, *in situ originali*, from gravels of the pliocene and post-pliocene epochs (Foster, "Prehistoric Races of America," p. 55). This is in direct conflict with everything yet known of the older stone age elsewhere.

The present specimen illustrated anew how natural forces occasionally simulate in their products the results of hand-work. The criteria of the latter are, however, well-ascertained, and by observing them one can scarcely be deceived in examining any series of examples.

DECEMBER 30.

Mr. George W. Tryon, Jr., in the chair.

Forty-one persons present.

The following were ordered to be printed:—

HOMOLOGIES OF THE VERTEBRATE CRYSTALLINE LENS.[1]

BY BENJAMIN SHARP, M. D., PH. D.

I cannot better introduce my subject than by quoting the following passage from Chas. Darwin: "To suppose that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection seems, I freely confess, absurd in the highest possible degree. Yet reason tells me that, if numerous gradations from a perfect and complex eye to one very imperfect and simple, each grade being useful to its possessor, can be shown to exist; if, further, the eye does vary ever so slightly, and the variations be inherited, which is certainly the case; and, if any variation or modification in the organ be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, can be hardly considered real. How a nerve comes to be sensitive to light, hardly concerns us more than how life itself first originated; but I may remark that several facts make me suspect that any sensitive nerve may be rendered sensitive to light, and likewise to those coarser vibrations of the air which produce sound. . . ."[2]

"If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find out no such case. No doubt many organs exist of which we do not know the transitional grades, more especially if we look to much-isolated species, round which, according to my theory, there has been much extinction. . . ."[3]

"In the cases in which we know of no intermediate or transitional states, we should be very cautious in concluding that none

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[1] Being the principal part of an address delivered before the Biological Section of the Academy of Natural Sciences of Philadelphia, December 15, 1884.

[2] Darwin, Chas., "On the Origin of Species, by Means of Natural Selection, etc." New York (Appleton), 1861, p. 167.

[3] Darwin, Chas., Orig. of Species, etc., p. 169.

could have existed, for the homologies of many organs, and their intermediate states, show that wonderful metamorphoses in function are at least possible." [1]

It will be my endeavor to show the stages of development of the eye from the simple deposit of pigment in an epithelial cell to the highest form known to us, that of the vertebrata.

Invagination seems to be the most simple, as well as one of the commonest, methods by which organs are formed in the animal series. The formation of the gastrula, of the medullary canal, the development of glands, etc., etc., by invagination, are cases too well-known to require further comment. The formation of the eye, ear, and nose, form no exception to this rule.

In a previous paper [2] I have endeavored to show that the simplest expression of an organ of sight is found in the Lamellibranchiata. These simple organs, however, are not morphologically the primitive visual organs of the group, but *adaptive organs*, the ancestral eyes being present, in a few forms, only for a short time during the free larval stage of the animal; it is lost when the animal becomes fixed and the head excluded from the light.

We will hastily review these simple eyes. One of the simplest cases is found in *Ostrea virginica* (fig. 1), in which we have, on the free edge of the mantle, a number of epithelial cells containing a nucleus (*n*), a deposit of pigment (*p*) in their exterior extremities, and on the outer surface a fine transparent, refractive cuticula (*c*). There seems to be no protection for the organ, save the power of withdrawal of the whole mantle within the valves of the shell. Experiment conclusively proves that sight exists in these animals, as shown by Ryder.[3]

FIG. 1.—Visual cells of *Ostrea virginica*. *c*, cuticle; *p*, pigment; *n*, nucleus.

We next find these pigmented visual organs confined to a certain point of the mantle which has become specialized into the so-called siphon. In *Venus mercenaria* we have these cells, unprotected on the external surface of the siphon, but at the same time some cells are more or less protected at the base of the tentacles; but as this animal is able to retract the entire

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[1] Darwin, Chas., Orig. of Species, p. 182.

[2] Sharp, B., On the Visual Organs in Lamellibranchiata. Mittheil. a. d. Zool. Stat. zu Neapel, Bd. v, 1884, p. 447.

[3] Ryder, J. A., Primitive Visual Organs. Science, vol. ii, No. 44, 1883, p. 739.

siphon within the shell, protection is thus afforded to these delicate organs.

When we find forms which are unable to wholly retract the siphon within the shell, the visual cells are confined to grooves at the bases of the tentacles. In the rapid withdrawal of the siphon through the sand, in cases of danger, we can easily see that the sharp particles would irritate any delicate organ, and protection must be afforded to them. Now, the possession of sight at the only exposed portion of the animal, would be of the highest value, in the struggle of life, to its possessor, if, when a shadow, like that of a rapacious fish, is thrown upon the organ of sight, a rapid retraction will save it from being nipped off.

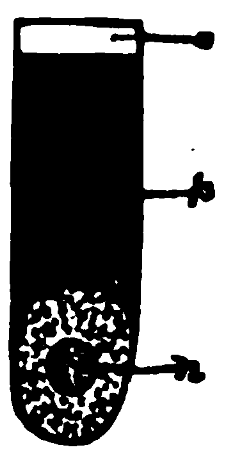

FIG. 2.—One visual cell of *Solen vagina*. *c*, cuticle; *p*, pigment; *n*, nucleus.

In *Solen vagina* and *S. ensis*, the former being the species on which I first satisfactorily proved the existence of a visual sense,[1] we find the cells have become much more developed, as is seen in fig. 2 (this being drawn to the same scale as that of fig. 1), but are essentially on the same plan as those in *Ostrea*. These cells line deep grooves at the bases of the tentacles and are found nowhere else, thus being amply protected from any injury. The nerves supplying these visual cells are probably the nerves of general sensibility, perhaps somewhat specialized.

The remarkable organs of *Pecten* and *Spondylus*, I will not here consider, as they throw no light on our immediate subject, and have been considered by me elsewhere.[2]

In passing next to a higher group, the Gastropoda, from which the Lamellibranchiata have probably degenerated, marked steps in advancement are to be noted.

In *Patella* we find that the pigment spots, or visual organs, take their morphological position, namely in the oral end of the body, and consist of a single pair in the base of the broad tentacle. More than a single pair of eyes are not found in the Gastropoda.[3]

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[1] Sharp, B., On Visual Organs in *Solen*. Proc. Acad. Nat. Sci. Phila., Nov. 6, 1883, p. 248; also, On the Visual Organs in Lamellibranchiata.

[2] Sharp, B., On the Visual Organs in Lamellibranchiata.

[3] The adaptive dorsal eyes of *Onchidium* form an exception, but the normal pair of cephalic eyes are present. See Semper, Carl, Ueber Sehorgane von Typus der Wirbelthiereaugen am Rücken von Schnecken. Wiesbaden (Kreidel), 1877.

In *Patella*, as shown by Fraisse,[1] there is a simple sphere, made up of pigmented cells, similarly formed as those described for the Lamellibranchiata. This sphere is open in front and allows the entrance of the external media.

Haliotis[2] gives us an advance; here we have an open sphere as in *Patella*, but instead of the refractive cuticula to each cell, they are physiologically combined into one mass, forming a lens. This lens is the product of the cells of the eye, and is purely a secretion—a simple cuticular lens, as is found in all the eyes of the invertebrata—while the lens of the vertebrata, where it exists, is always cellular. The cellular lens-like bodies found in the so-called eyes of *Pecten* and *Spondylus*, and the dorsal eyes of *Onchidium*, are exceptional, and will be treated of elsewhere.

Fissurella[1] gives us an eye that goes practically as far as any gastropod eye, the higher forms merely carry out, a little more in detail, this plan. This results in a closed eye containing a lens, the transparent epidermal covering acting as a cornea. The pigmented layer is as in *Haliotis*, namely, the cells composing it are devoid of a transparent cuticula, the lens and cornea serving as the refractive bodies.

The phylogenetic development of the molluscan eye, therefore (cephalopoda excepted), is as follows: (1), a pigmental surface of epithelial cells; (2), pigmented invaginated grooves for protection, at centralized points of the body, each visual cell having a cuticular body; (3), this groove contracting to an open sphere which closes; (4), the refractive bodies of each cell being centralized into a cuticular lens. A distinct nerve, specialized for sight, is developed (*Haliotis* and *Fissurella*), which connects the eye with the superior cephalic ganglia.

Now, let us see how the ontogenetic development agrees with the phylogenetic.

Bobretzky[3] and Haddon[4] have given us the development of

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[1] Fraisse, Paul, Ueber Mollusken Augen mit embryonalem Typus. Zeitschr. f. wis. Zool., Bd. xxxv, 1881.

[2] Fraisse, Paul, Ueber Mollusken Augen mit embryonalem Typus. Zeitschr. f. wiss. Zool., Bd. xxxv, 1881.

[3] Bobretzky, N., Studien über die embryonale Entwickelung der Gastropoden, Arch. f. mikr. Anat. Bd., xiii, 1877.

[4] Haddon, A. C., Note on the Development of Mollusca, Quart. Jour. Mic. Sci., n. s., vol. xxii, 1882.

the gastropod eye, the former in *Fusus*, and the latter in *Murex*. I have carefully investigated the embryological growth of this same organ in *Nassa*, and lastly, Carrière[1] gives an account of the regeneration of the eye after amputation in the Pulmonata.

We find that ontogeny merely recapitulates phylogeny, as we would naturally anticipate. There is first an invagination, which closing forms a sphere; in the cells of this invagination there is a deposit of pigment, and from them a cuticular lens is formed, which increases in size by the addition of concentric layers. A nerve is there developed and connects this eye with the superior cephalic ganglia.

We will now pass to consideration of the eyes of the vertebrata, which, with a few exceptions, are remarkable for the similarity in general plan of organization throughout the whole group.

I will not enter here into a detailed account of the work that has been done on this subject, nor into a description of the finer anatomy, except where necessary to illustrate points under consideration. I leave these to a future and more exhaustive work upon the "Anatomical and Physiological Evolution of the Organ of Vision," upon which my friend, Dr. Charles A. Oliver, and myself are now engaged, and which is to appear under our joint names.

The general structure of the eye of the vertebrata is well known, and I will here simply draw attention to some of the cardinal points.

The eye consists of a more or less spherical body, bounded in front by a transparent plate, the *cornea*, which is a continuation of the white opaque enveloping sheath of the eye-ball, called the *sclerotica*. Internal to this *sclerotica* is a layer of pigment (*choroïdea*), passing forward to about the position of the junction of the *cornea* and *sclerotica*, and also extending over the posterior wall of the iris. Lying on this pigmented layer is the *retina*, the sensory portion of which is considered to be a continuation of the optic nerve, and which passes beyond the equator of the eye to a point called the *ora serrata*. The cavity of the eye-ball is divided anterio-posteriorly into two principal chambers, the anterior one is again subdivided into two, called the anterior and the posterior chamber, and includes all the space anterior to

[1] Carrière, Jus., Studien über die Regenerationserscheinungen bei den Wirbellosen. I. Die Regeneration bei den Pulmonaten. Würzburg, 1880.

the lens. The anterior chamber is divided from the posterior by the iris, the latter being a flattened projection of the vascular layer of the *choroïdea*. The hole in its centre is called the pupil. These two chambers are filled with a fluid called the *humor aqueus*. Back of the lens and *iris* is the largest chamber of the eye-ball, called the vitreous chamber, and contains a semi-fluid mass, known as the *corpus vitreum*.

The lens is a *cellular* body, suspended from the *process ciliaris* by the suspensory ligament; the *process ciliaris* of the *iris*, is an extension of the vascular layer.

The *retina* is composed of many layers; one of the most external, that which is directed toward the *choroïdea*, is called the layer of the rods and cones. The innermost layer, that next to the *corpus vitreum*, is the layer of fibres of the optic nerve; between these two are several ganglionic layers. The whole retina is practically transparent, and the light passes through it unchanged to the point of contact of the rods and cones with the pigmented layer. Here the light-motion is transferred into a "nerve-energy," which is transmitted to the perceptive centres of the brain,[1] no light-motion, of course, passes beyond the receiving sensory fibres internally. The optic nerve pierces the retina a little on the nasal side of the optic axis. It will thus be seen that the extraneous color-waves have, in their impinging upon the sensory tips of the rods and cones, passed through the entire thickness of the retina, before it has been put in a position to give a proper sensory impression. In fig. 3, I have given a diagrammatical representation. *R* is a ray of light passing through the retina, and impinging on the point of a rod or cone, *n* representing the return through the cells of the retina (*r*) to the nerve-fibres, and then passing by them to the brain, *B*.

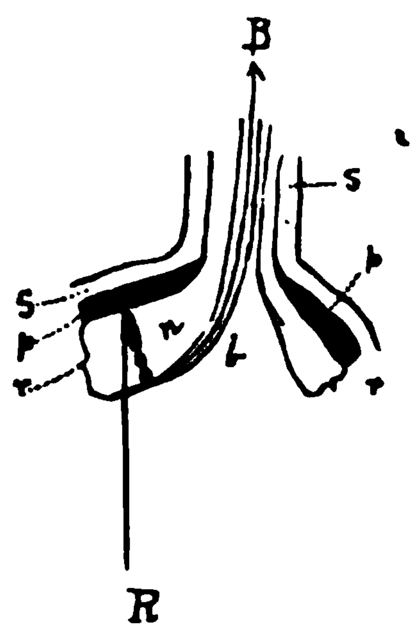

Fig 3.—Diagram representing the course of light, *R*, in the eye of a vertebrate, and "nerve-energy" through the retina to the brain, *B*. *S*, sclerotica; *p*, pigment; *r*, retina; *b*, blind spot; *n*, is the return through the retina of the nerve-energy.

Now, to consider the development of the eye, we find that in

[1] For a detailed account of this, see the forthcoming paper of Oliver, Charles A., "A Correlation Theory of Color Perception," Amer. Jour. Med. Sci., Jan., 1885. Dr. Oliver has kindly allowed me access to the manuscript of this article.

an early stage of the embryology of a vertebrate, the anterior end of the medullary groove, or canal, as the case may be, is divided into three segments, which later form the brain. The anterior of these is known by the name of fore-brain, or *proencephalon*; the middle one, or mid-brain, is called *mesencephalon*; and the posterior, the hind-brain, or *metencephalon*.

From the fore-brain proceeds outwards and laterally a swelling, which increases in size, and passes on to the epidermis. Here an invagination takes place, inward, to meet this outward brain-growth. This invagination finally closes, and soon becomes cut off, to form a hollow vesicle, the cavity of which is finally obliterated, and, becoming transparent, forms the lens of the adult eye. In the meantime, the growth from the brain has arched over and above this vesicle, and then folds over laterally to enclose the lens. This process of the brain is hollow, and communicates with the ventricular cavities of the brain.[1] This differentiation which has taken place, to form the so-called "secondary optic vesicle," is hardly an invagination in the true sense of the word, but is rather a double-walled plate, which folds downwards around the lens, this is indicated in the diagrammatic representation in fig. 4. The lens fills up the anterior opening of the cavity of the secondary optic vesicle, and as the two edges, *a* and *b*, close around the under surface of the lens, a certain amount of mesodermic tissue is included, which later forms the transparent *corpus vitreum*. After the closure is completed, there is a double-walled vesicle, the interior wall is the thicker of the two, and later gives rise to the many-layered *retina;* the external wall forms the pigment layer of the *choroïdea*. It not unfrequently happens that we find incomplete closure of the secondary optic vesicle, and when this is the case in the adult eye, the pathological condition known to physicians as *coloboma* exists. This may take place in the *iris* (*coloboma iridis*), or in the *retina*

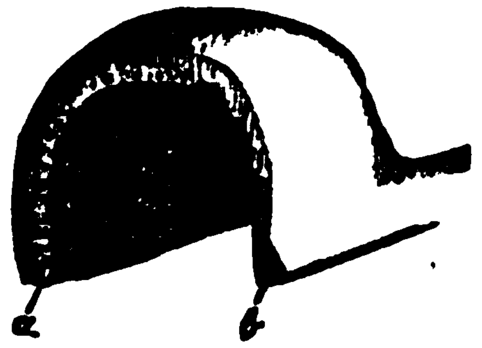

FIG. 4.—Diagram to illustrate the method by which the secondary optic vesicle encloses the lens which should fill up the open end. Eye of vertebrate.

[1] It must be borne in mind that the interior of the lens was once a part of the general surface of the body, and also the interior of the secondary optic vesicle, proceeding first by the formation of the medullary groove, and then from that inward.

(*coloboma retinæ*); in the latter case, on examining the eye with an ophthalmoscope, we can see a wedge-shaped white patch, the base downwards, at the inferior part of the background of the eye, the white is the sclerotica shining through. This is merely a reversion to a primitive state—a failure in the union, posteriorly, of the two lateral walls of the secondary optic vesicle.

The optic nerve is formed by the bending over, and union below, of the connecting portion of the secondary optic vesicle with the fore-brain. The portion of mesoderm included by this process is later termed the *arteria centralis retinæ*. The *sclerotica* and the vascular layer of the *choroïdea* are formed from the mesoderm, and are merely organs for the nourishment and the protection of the nerve-elements within.

It seems to me that the steps taken in ontogenic development of the eye, point out to us that the course which has been pursued in its phylogenesis from a simple epithelial pigmentary deposit, is as follows: The first visual organ primarily consisted of a deposit of pigment, centralized at that portion of the animal where it will be of the most use, viz.: at the oral pole. Since animals as a rule proceed with this extremity forward, they are developed in this situation; but in some cases, as in the Lamellibranchiata, as pointed out above, they are developed at that portion of the body which needs their protection. The next step in advance is to protect these important organs, and as a consequence invaginated grooves result, which gradually shorten to form a sphere. The refracting media of separate cells soon coalesce, to produce a cuticular lens. The nerves of general sensibility, connecting this eye with the brain, soon become specialized, and form a distinct (primitive) optic nerve. As the eye increased in importance and usefulness to its possessor, a corresponding stimulation took place in the brain, where sight is without doubt seated. Increased activity in any organ causes a corresponding increase in blood-supply—or better, *nutriment-supply*—and an increase of development took place all along the tract, from the eye to the seat of vision in the brain. As this increased, that part of the brain nearest the eye enlarged, and proceeded by steps *toward* the eye, similar to the process now taking place in the development of the eyes of the *Vertebrata*, the primitive optic nerve still connecting the two. We then have a stage in which a part of the brain closes over the superior part of the

eye, being separated by a layer of fibres, which is the much-shortened and flattened primitive optic nerve. The pedicle connecting this advanced part of the brain, which may be looked upon as a ganglion, we will now call the "secondary optic nerve," the optic nerve of the eyes of the adult *Vertebrata*. A similar state of affairs as this is found to-day in the eyes of the *Cephalopoda dibranchiata*. This ganglion soon becomes the most important part of the eye, and receives the light-waves upon its exterior wall, the primitive eye becoming transparent, and later forming the lens. This "*ganglion opticum*," as it may be provisionally called, gradually proceeds downwards about the primitive eye, joining below. As development and importance advance, we find the hollowing out of the *ganglion opticum*, this structure later is filled with the *corpus vitreum*, which is included, as was shown in the development of the eyes of the *Vertebrata*. Thus, I hold, if this hypothesis be a true one, that (1) the lens of the eyes of the *Vertebrata* is homologous with a primitive invaginated eye, such as we find to-day in the gastropoda; that (2) the layer of optic fibres of the *retina* is homologous with the primitive optic nerve. As the *retina* below has become the sensory part of the eye, the rays of light must necessarily pass through it, to reach a point where nerve-energy is developed. The *nervus opticus* of the eyes of the *Vertebrata* is, therefore, according to this view, really a secondary optic nerve.

We find in the vertebrata, and much more frequently in the invertebrata, blind animals, the near relatives of which have well-developed organs of sight. This blindness is due to the peculiar environments of the animal, such as cave life, where light is excluded; parasitism, etc., etc.

The *Proteus* of the Adelsberg grotto is an animal that is practically devoid of pigment. The eye of this practically blind animal is remarkable, inasmuch, that no lens is developed in the adult state. Our literature is unfortunately deficient in the embryology of this interesting form, so it is at present a matter of impossibility to state whether there *ever* exist a lens in the early development of the eye. The primitive optic vesicle has the form of that of the embryos of those vertebrates which have well-developed eyes in the adult state; the retina is a thick, many-celled layer, lying on the *stratum pigmentum*, which contains

a very meagre deposit of pigment; the anterior edge of this double-walled cup, formed by the retina and pigmented layer, come together, owing to the absence of the lens. It is stated[1] that no *corpus vitreum* is present. This degenerate eye is of little use to the animal, and, besides the loss of the lens, it is covered by the general integument of the body. Now it may be argued, upon my hypothesis, that the lens should be last to disappear, being phylogenetically the *first* to appear; but as the secondary optic vesicle has taken up the principal function of the eye, viz.: the developing of nerve-energy, we would naturally expect that the *accessory* organs would be the first to disappear in the process of degeneration; hence, the lens modified to an organ of refraction, although the most primitive part of the eye, would disappear before the secondary optic vesicle, since it has lost its function as an eye and acts merely as a refractive agent.

Another objection may be raised, which may be well to insert here, viz.: Why should the process from the proencephalon start before the invagination, to form the lens, the former being a secondary state in the phylogeny of the animal? I would explain this by the fact that as the optic vesicle, being now the most important part of the eye, and so established for many generations, now appears *first* and disappears *last* in degeneration.

In *Myxena glutinosa*, as described by Wm. Müller,[2] we have an eye consisting of the secondary optic vesicle, as in the case of *Proteus*, but open in front and filled with a plug of mesodermal tissue. The eye is entirely devoid of pigment and lies buried beneath a layer of muscle underlying the skin. The optic nerve passes into the vesicle, and terminates *in* the retina, there being no layer of optic nerve-fibres present at all. This eye has proceeded a step further in its degeneration, than the eye of *Proteus*, being *entirely* devoid of pigment, and having become more deeply imbedded, is covered by a layer of mesodermal tissue, the muscular stratum.

Thus in degeneration, the eye proceeds, step by step, backwards towards the brain, after first losing its accessories, such as the lens, *cornea*, *sclerotica*, etc.

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[1] Semper, Carl. Animal life as affected by the natural conditions of existence. Intern. Sci. Series, vol. xxx, New York (Appleton), 1881, p. 78.

[2] Müller, Wm. Ueber die Stammesentwickelung des Sehorganes der Wirbelthiere. Festgabe an Carl Ludw'g. Leipzig (Vogel), 1875, p. vii.

In *Branchiostoma lanceolatum* we find the degeneration has reached its greatest extreme. There exists no trace of the eye, in form, and we recognize its existence only by a slight deposit of pigment on the anterior end of the neural canal. The brain itself has disappeared in this degenerate form, it going hand in hand with the eye, so that the only remnant of it is a spot of pigment on the anterior end of the neural canal.

Now this deposit of pigment that we find in *Branchiostoma*—and a similar deposit in the nerve-centres of some of the larvæ of the Ascidia, looked upon at one time as the ancestors of the Vertebrata, while they are if Vertebrata at all, greatly degenerated ones—led Lankester[1] to regard the primitive type of the Vertebrata as a transparent animal with eyes sessile on the brain. I am of the opinion that forms so degenerate as *Branchiostoma* and the *Ascidia* should not be taken as a standard, on which to base our conclusions for the origin of the Vertebrata.

In conclusion I may quote a passage from Tyndall,[2] which we have taken for our motto: "The eye has grown for ages *toward* perfection, but ages of perfect*ing* may still be before it."

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[1] Lankester, E. R., Degeneration, a Chapter in Darwinism. Nature series. London, 1880.

[2] Tyndall, John, Six Lectures on Light. London, 1878.

A REVIEW OF THE AMERICAN SPECIES OF STROMATEIDÆ.

BY MORTON W. FORDICE.

In the present paper I have attempted to collect the synonymy of the American species of *Stromateidæ*, and to give an analytical key for the identification of the species.

The specimens studied belong to the Museum of Indiana University.

Analysis of American Genera of Stromateidæ.

a. Ventrals very rudimentary or absent; preopercle entire; anterior rays of dorsal and anal fins more or less produced; scales very small and thin; caudal peduncle slender, not keeled; gill-membranes free from isthmus; caudal fin forked. *Stromateus.* I.

aa. Ventrals present, I, 5; edge of preopercle serrate; anterior rays of dorsal and anal fins not produced; scales rather small, firm; gill-membranes free from isthmus; caudal peduncle rather stout, not keeled; caudal fin lunate. *Leirus.* II.

I. STROMATEUS.

Stromateus Linnæus, Syst. Nat., x, 248, 1758 (*fiatola*; *paru*).

Rhombus Lacépède, Hist. Nat. Poiss., ii, 321, 1800 (*alepidotus*).

Chrysostromus Lacépède, Hist. Nat. Poiss., iv, 97, 1800 (*fiatoloides* = *fiatola*).

Fiatola Risso, Eur. Merid., iii, 289, 1826 (*fasciata*).

Peprilus Cuvier, Regne Animal, 1828 (*crenulatus*).

Seserinus Cuvier & Valenciennes, Hist. Nat. Poiss., ix, 416, pl. 276, 1833 (*microchirus*).

Poronotus Gill, Cat. Fish. East Coast N. A., 1861, 35 (*triacanthus*).

Analysis of American Species of Stromateus.

a. Pelvis ending in a small spine; ventral fins entirely wanting.

b. Dorsal and anal fins falcate; the length of their highest rays greater than that of head; back elevated; body suborbicular; snout vertical; height of body $1\frac{1}{2}$ in length; D. III, 45; A. II, 43; vertebræ, 13+17; occipital crest very high, its vertical height from supra-occipital bone contained 3 in head (*Rhombus* Lac.). *paru.* 1.

bb. Dorsal and anal fins little falcate; the length of their highest rays less than head.

c. Region below dorsal fin with a series of pores; outline elliptical; height of body $2\frac{1}{3}$ in length; D. III, 45; A. III, 37; vertebræ, 14+19; occipital crest moderate, the height from supra-occipital bone 4 in head (*Poronotus* Gill). *triacanthus*. 2.

cc. Region below dorsal fin without conspicuous pores.

d. Form elliptical; height of body $2\frac{1}{4}$ in length; D. III, 45; A. II, 39; vertebræ, 14+17; occipital crest low, its height from supra-occipital bone $4\frac{3}{4}$ in head. *simillimus*. 3.

dd. Form broad-ovate; height of body, $1\frac{9}{10}$ in length; dorsal with 42 developed rays; anal with 32. *medius*. 4.

aa. Pelvis not ending in a spine (*Stromateus*); no trace of ventral fins.

e. Upper part of body with numerous round black spots; head, $4\frac{1}{3}$; depth, $2\frac{1}{4}$; D. VII, 40–43; A. III, 38. *maculatus*. 5.

1. **Stromateus paru.**

Paru Brasiliensi congener Sloan, Jamaica, 2, 285, tab. 250, f. 4, 1727 (Jamaica).

Stromateus paru Linnæus, Syst. Nat., ed. x, 248, 1758 (based on Sloan's description); *ibid.*, ed. xii, 487, 1766; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 597 (Charleston, S. C.); Jordan & Gilbert, Syn. Fish. N. A., 914, 1882.

Chætodon alepidotus Linnæus, Syst. Nat., ed. xii, 460, 1766 (Charleston); Gmelin, Syst. Nat., 1240, 1788 (copied).

Rhombus alepidotus Lacépède, Hist. Nat. Poiss., ii, 321, 1800 (copied).

Peprilus alepidotus Goode, Proc. U. S. Nat. Mus., 1879, 112 (Fernandina); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 130 (Pensacola); Bean, Proc. U. S. Nat. Mus., 1880, 92 (Beaufort, N. C.; Norfolk).

Stromateus alepidotus Lütken, Spolia Atlantica, 1880, 521; Jordan & Gilbert, Syn. Fish. N. A., 1882, 451; Bean & Dresel, Proc. U. S. Nat. Mus., 1884, 156 (Jamaica); Jordan & Gilbert, Proc. Acad. Nat. Sci. Phila., 1884 (Egmont Key).

Sternoptyx gardenii Bloch & Schneider, Syst. Ichth., 494, 1801 (Carolina).

Stromateus gardenii Günther, Cat. Fish. Brit. Mus., ii, 399, 1860 (New Orleans; Jamaica; Bahia).

Stromateus longipinnis Mitchill, Trans. Lit. Phil. Soc. New York, i, 366, 1814 (New York Bay).

Rhombus longipinnis Cuvier & Valenciennes, Hist. Nat. Poiss., ix, 401, pl. 274, 1833 (New York); Dekay, New York Fauna, Fish, 136, pl. 75, f. 239, 1842.

? *Seserinus xanthurus* Quoy & Gaimard, "Voy. Freyc. Zoöl., 384, 1824."

? *Rhombus xanthurus* Cuvier & Valenciennes, Hist. Nat. Poiss., ix, 405 (Brazil).

? *Rhombus argentipinnis* Cuvier & Valenciennes, Hist. Nat. Poiss., ix, 405, 1833 (Montevideo).

? *Rhombus crenulatus* Cuvier & Valenciennes, Hist. Nat. Poiss., ix, 410, 1833 (Cayenne).

? *Rhombus orbicularis* Guichenot, "Mem. Soc. Imp. Sc. Natur. Cherbourg, xii, 245, 1866" (Cayenne).

Habitat.—New York to Jamaica, also *probably* southward to Brazil.

As Dr. Bean has shown the identity of the northern fish with that found in Jamaica, there seems to be no doubt of the propriety of retaining the name *paru* for this species.

Possibly the South American species (*xanthurus*) is different, the number of fin rays being given as D. IV, 40; A. III, 39.

2. **Stromateus triacanthus.**

Stromateus triacanthus Peck, "Mem. Amer. Acad., ii, pt. 48, pl. 2, f. 2, 1804" (New Hampshire); Günther, Cat. Fish. Brit. Mus., ii, 398, 1860 (Boston; New York); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 597 (Charleston, S. C.); Jordan & Gilbert, Syn. Fish. N. A., 451, 1882.

Peprilus triacanthus Storer, Fish. Mass., 60, 1839 (Massachusetts).

Rhombus triacanthus Dekay, New York Fauna, Fish, 137, pl. 26, 1842 (New York Harbor).

Poronotus triacanthus Gill, Cat. Fish. East Coast N. A., 1861, 35; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 377 (Beaufort, N. C.); Bean, Proc. U. S. Nat. Mus., 1880, 91 (Wood's Holl, Mass.; Noank, Conn.; Eastport, Me.; Portland, Me.; Norfolk, Va.; Tompkinsville, N. Y.; Banquereau; Vineyard Sound; Gloucester, Mass.).

Stromateus cryptosus Mitchill, Trans. Lit. Phil. Soc. New York, i, 365, pl. 1, f. 2, 1814 (New York Bay); Cuvier & Valenciennes, Hist. Poiss., ix, 408, 1833.

Habitat.—Nova Scotia to Charleston.

The nomenclature of this species offers no difficulties. The generic name *Poronotus* proposed for it by Dr. Gill, seems unnecessary, as the species is evidently very closely related to *S. simillimus*, which lacks the series of pores, on which *Poronotus* was based.

On examination of the skeletons of the three species, *S. paru*, *triacanthus*, and *simillimus*, I find the first interhæmal greatly developed in each of the species. The occipital crest is very high in *S. paru;* it is medium in *S. triacanthus*, and low in *S. simillimus*. The hæmal and neural spines are more developed in *S. paru* than in the other species, thus corresponding to the form of the body. The vertebræ in *S. triacanthus* are somewhat more numerous than in the others, as stated in the analytical key.

3. Stromateus simillimus.

Poronotus simillimus Ayres, Proc. Cal. Acad. Nat. Sci., 1860, 84 (San Francisco); Cooper, Nat. Wealth Cal., 1868, 489.

Stromateus simillimus Rosa Smith, Fish. San Diego, 1880 (San Diego); Jordan and Jouy, Proc. U. S. Nat. Mus., 1881, 12 (San Diego; Santa Barbara); Jordan and Gilbert, Proc. U. S. Nat. Mus., 1881, 46 ("Entire Pacific Coast, common, but most abundant from Santa Barbara to San Francisco"); Bean, Proc. U. S. Nat. Mus., 1881, 265 (name only); Jordan and Gilbert, Syn. Fish. N. A., 1882, 451.

Habitat.—Puget Sound to San Diego.

This species is common along the Pacific Coast, where it replaces *S. triacanthus* of the Atlantic Coast.

4. Stromateus medius.

Stromateus medius Peters, Berliner Monatsbericht, 1869, 707 (Mazatlan); Lütken, Spolia Atlantica, 1880, 521; Jordan, Proc. Phila. Acad. Nat. Sci., 1883, 284 (original type).

This species is now only known from the original type in the Museum at Berlin, erroneously described by Dr. Peters. In 1882 numerous specimens were collected at Panama by Prof. C. H. Gilbert, but all of these have been since destroyed by fire.

5. Stromateus maculatus.

Stromateus maculatus Cuvier and Valenciennes, Hist. Nat. Poiss., ix, 399, 1833 (Valparaiso); Jenyns, "Zool. Beagle, Fishes," 74, 1839; Gay, "Hist. Chile, Zool.," ii, 248, Atl. Ictiol. lam., 3 bis, f. 1; Günther, Cat. Fish. Brit. Mus., ii, 398, 1860.

Habitat.—Coast of Chili.

Head[1] 4⅓ in length of body; depth 2¼; D. VII, 43; A. III, 39. Scales in lateral line about 160. Body ovate, compressed,

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[1] The description of *Stromateus maculatus* was added by Seth E. Meek, who alone is responsible for it.

dorsal and ventral outlines very similar to each other. Profile evenly convex (with curve a little shorter at occiput) to snout in front of nostrils, where it descends almost vertically. A slight depression on each side of head, above nostrils, which makes the profile more trenchant at that place.

Mouth not very small; the tip of maxillary does not quite reach vertical from front of eye; its length about $4\frac{1}{2}$ in head. The teeth of the lower jaw pass just behind those of the upper jaw, when the mouth is closed. Eye small, $5\frac{1}{2}$ in head. Pseudobranchiæ well developed. Gill-rakers weak and flexible, 12 below the angle, the longest about $\frac{2}{3}$ eye. Preopercle entire. Branchiostegals 6. Pelvis not ending in a spine. No trace of ventral fins. No pores along the base of dorsal fin. The soft dorsal and anal fins similar to each other, except that the anterior rays of dorsal are correspondingly higher than those of the anal.

The dorsal spines are distant from each other, and quite imbedded in the skin. The first spine is on the vertical above, from upper part of gill-opening. Distance of first ray of soft dorsal to tip of snout equals the depth of the body. Distance from first ray to last ray of soft dorsal is contained $1\frac{3}{4}$ in length of body. Distance of first ray of anal to tip of snout about 2 in length of body. Base of anal 2 in length of body.

The mucus-pores on upper anterior part of head form a sort of irregular network. A main branch arises a little anterior to upper part of gill-opening, which sends off branches, extending backwards almost straight, and parallel to each other.

The greatest width of head 2 in its length; the greatest width of body (midway on a line from upper part of gill-opening to base of last anal ray) $2\frac{1}{2}$ in head. Cheeks and opercles scaly.

Color in alcohol blue above, with numerous round dark blue spots, about $\frac{1}{2}$ as large as eye; below silvery. Below pectorals, on anterior half of body, are some irregular blue markings. Pectorals blue; caudal yellowish, with faint bluish shade on tips of its rays. The pectoral fins are about as long as head.

The above description was taken from a specimen in very good condition, from Rio Grande do Sul, South America. The specimen is in the Museum of the Academy of Natural Sciences of Philadelphia. It was originally sent there from the Museum of Comparative Zoology. Length of specimen, 14 inches.

II. LEIRUS.

Leirus Lowe, "Proc. Zool. Soc., London," 1839, 82 (*bennetti* = *ovalis*).
Palinurus Dekay, New York Fauna, Fish, 118, 1842 (*perciformis*).
Crius Valenciennes, "Webb and Berthelot, Isles Canar. Poiss." (*bennetti*).
Pammelas Günther, Cat. Fish. Brit. Mus., ii, 485, 1860 (*perciformis*).
Palinurichthys Gill, Proc. Acad. Nat. Sci. Phila., 1860, 20 (*perciformis*).
Palinurichthys Bleeker, about 1860 (*perciformis*).

Analysis of American Species of Leirus.

a. Body ovate; the greatest depth, 2½ in length. Head, 3¼; D. VIII, 20; A. III, 16; Lat. l. 75. *perciformis.* 1.

aa. Body more elongate, its greatest depth 3½ in length. Head, 3; D. VIII–IX, 26–28; A. III, 18; Lat. l. 80–90. *peruanus.* 2.

I follow Jordan and Gilbert in regarding *Leirus* as a genus distinct from *Centrolophus*, from which it differs chiefly in the differentiation of the dorsal spines, and in referring to *Leirus*, the *Palinurichthys perciformis* of American writers, which appears to be a near relative of *Leirus ovalis*, although Dr. Günther has placed it among the *Carangidæ*.

1. **Leirus perciformis.**

Rudder fish or *Perch coryphene* Mitchill, Lit. Phil. Soc., i, pl. vi, f. 7, 1814 (no description).

Coryphene perciformis Mitchill, Am. Month. Mag., ii, 244, 1818 (New York Harbor).

Palinurus perciformis Dekay, New York Fauna, Fish, 118, pl. xxiv, f. 25, 1842 (Shrewsbury Inlet).

Pammelas perciformis Günther, Cat. Fish. Brit. Mus., ii, 485, 1860 (Coast of New York).

Palinurichthys perciformis Gill, Proc. Phila. Acad. Nat. Sci., 1860, 20 (name only); Bean, Proc. U. S. Nat. Mus., 1880, 91 (Wood's Holl, Mass.; Off Noman's Land; New York Market; Newport, R. I.; Gloucester, Mass.; Fishing banks, off coast of Maine).

Lirus perciformis Jordan and Gilbert. Syn. Fish. N. A., 452, 1882.

Trachinotus argenteus Storer, Mass. Rep., 55, 1839 (Holme's Holl, Mass.; not of Cuvier and Valenciennes).

Habitat.—Maine to New York.

This species has apparently but a limited range on our Atlantic coast. It is apparently congeneric with *Centrolophus ovalis* Cuv. and Val., the type of Lowe's genus *Leirus*.

2. **Leirus peruanus.**

Centrolophus peruanus Steindachner, Ichthyologische Beiträge, i, 10, 1874 (Callao).

Habitat.—Coast of Peru.

This species is known to me only from Steindachner's description.

ON A REMARKABLE EXPOSURE OF COLUMNAR TRAP NEAR ORANGE, NEW JERSEY.

BY PROFESSOR ANGELO HEILPRIN.

The remarkable exposure of trap, near Orange, New Jersey, to which attention has recently been called by the State Geologist, Prof. George H. Cook, is in many respects the finest example of geotechnic architecture to be found in the Eastern United States. Although a true columnar structure is by no means a rarity in this State, indeed, rather the contrary, yet strikingly enough, where any extensive exposure of the trap occurs, there the columnar structure appears to be in most instances either only partially developed, or where developed, only of a very indeterminate character. This is well shown in the case of the Palisades fronting the Hudson River, where, for the greater part of their extent, only an approximation to anything like such structure can be made out. In the case of the locality presently to be described, however, which is situated on the face of the first interior ridge trending parallel with the Palisades, whose age probably differs but little, if at all, from that of the Palisades, we are presented with the reversed condition of things; the columnar structure is here developed, not only on a most imposing scale, but in all the varied conditions under which such structures appear.

The exposure of O'Rourke's quarry (Plate VIII) is located some one and a half or two miles back of Orange, on the slope of Orange Mountain, and, consequently, in the line of the first trap ridge. It measures 750 feet in length, and 98 feet 2 inches greatest height above the base or working line. The material quarried (worked now for a considerable number of years) is the familiar post-Triassic (?) "trap," or "greenstone," the material of the Palisades quarries, which, until recently, supplied the city of New York with a great part of the Belgian paving blocks. That which immediately arrests the attention of the visitor to the quarry is the magnificent display of the columnar structure, thousands of basaltic columns of the hexagonal and pentagonal pattern appearing, if not in the absolute perfection of the similar columns of the Giant's Causeway and Fingal's Cave, in a perfection but very little inferior to these. The base or lower half of the exposure is

made up of a vertical palisade of 120 or more columns, measuring individually from 15 to 40 or 42 feet in height, and from 3 to 5 feet, or even more, in thickness. Towards the middle the height of this palisade has been greatly reduced, partly through the failing of the columns themselves, and partly through the artificial destruction that has here been effected. Above this line, which in some parts is sheared off as evenly as though it had been manipulated by the hand of man, the columns suddenly diminish in size, and instead of retaining the vertical position, now arch diagonally upward and outward, meeting from opposite sides to form an apex immediately under the highest point of the exposure. Many of the columns rest horizontally, or nearly so. Beyond the horizontal layer, what may be considered as a third series of columns makes its appearance, and here, again, the vertical position is assumed. The material of the glacial drift, as indicated by a heterogeneous assemblage of pebbles and boulders, rests on top, forming the subsoil of the region.

The first impression produced upon the casual observer by the complete exhibit is one indicating disturbance; the arched or diagonally inclined, and apparently disturbed, position of the columns of the upper and inner portion of the mass, would seem to imply an upheaving thrust from below, just underneath the apex. In other words, it would appear that we were over the seat of some subterranean disturbing force, or in the centrum of volcanic action, and, therefore, in the position of a true vent. But had there been such a thrust as is here implied, we should expect to see its effects revealed in a fracture or dislocation below the top, whereas none such is apparent. On the contrary, the continuity of the columnar mass is fully as well marked on top as anywhere else, and no indications of special disturbance are anywhere manifest. We are hence forced to the conclusion that the irregular and apparently disturbed position of the columns is not in reality due to any disturbing agent, but is merely the result of peculiar conditions of cooling and solidification of the original molten substance (lava). In other words, while some portions of this molten lava "crystallized" into vertical prismatic columns, other portions "crystallized" horizontally, and in all the intermediate planes lying between the horizontal and vertical. This irregular method of columnar formation, a perfect parallel of

which is observed along the River Alignon in the Ardèche, was first critically discussed by the late Poulett Scrope, who investigated its causes midst the volcanic debris of Central France, and clearly determined that it was the result of irregular convection and radiation of heat, and consequent irregular solidification. The deep layers, where the loss of heat was effected slowly through conduction with the underlying rock, produced stout vertical columns; the more superficial layers, where radiation was most active, frequently produced horizontal columns, while between the two were found columns occupying all the intermediate positions.

NOTES ON SOME NEW FORAMINIFERA FROM THE NUMMULITIC FORMATION OF FLORIDA.

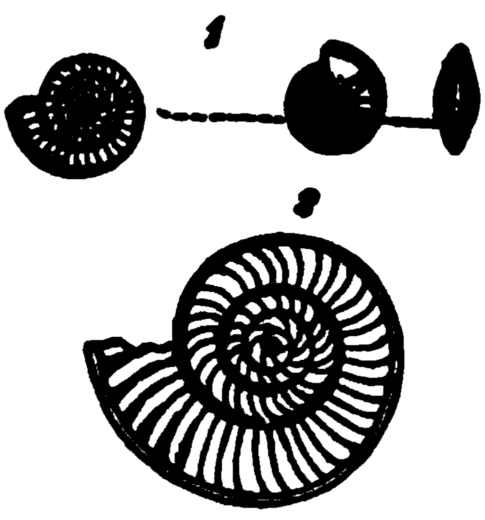
BY PROFESSOR ANGELO HEILPRIN.

Since the publication of my paper on *Nummulites Willcoxi* Heilprin (Proc. Acad. Nat. Sciences, July, 1882; reprinted in my "Contributions to the Tertiary Geology and Paleontology of the United States," Phila., 1884), in which the existence of a true Nummulite in the rocks of the North American continent was first indicated, I have had the good fortune to have passed under my supervision an extensive series of the Florida nummulitic rock. In these, for which I am indebted to the kindness of Mr. Joseph Willcox of this city, I have detected a considerable number of foraminiferal forms which have not hitherto been recognized, I believe, as occurring in the United States Tertiaries, but which are usually present in larger or smaller quantities wherever the nummulitic formation is largely developed. Among these, as coming from Hernando County, are the genera *Heterostegina*. *Sphæroidina*, *Biloculina* (?), *Triloculina*, *Quinqueloculina*, and *Spiroloculina*. The genus *Orbitoides* is very abundantly represented in two or more species, one of which, unmistakably the *O. ephippium* (*O. sella*), so distinctive of the Oligocene portion of the European *Terrain nummulitique*, appears pre-eminent for its large size. The great development of this species, irrespective of all other evidence, would almost be sufficient by itself to determine the age (Oligocene) of the rock formation in which it occurs.

Associated with these forms are very considerable numbers of the *Nummulites Willcoxi*, and also a second species of the same genus of very much larger size. In it the whorls expand very rapidly in size, and the septa, in addition to being comparatively more numerous, are considerably more flexed than in the commoner species. The test measures between one-third and one-half of an inch in diameter. I propose naming this species *Nummulites Floridensis*, though I am by no means satisfied that it may not prove to be identical with one of the many closely related forms that have

Nummulites Floridensis.

been described from the south of Europe, the West India Islands, and elsewhere. Only an actual comparison of specimens can, in most instances, determine specific identity or variation in the case of this most difficult group of organisms. Pending the interval which must of necessity intervene before such comparison can be made, I have deemed it the safer plan to describe and name the species, subject to revision.



Nummulites Willcoxi.
1. Natural size; 2. Enlarged.

A new locality for *Nummulites Willcoxi* has been found by Mr. Willcox, situated some fifteen miles to the northeast of the locality on the Cheeshowiska River, whence the species was originally obtained. Here the rock masses containing the fossils lie *in situ*, and at an elevation of not less than 150 feet above the sea. The existence of a true nummulitic basement formation in the State of Florida is thus placed beyond question, and, doubtless, the same will be found to have a very considerable extension inward.

No specimens of the *Operculina rotella* (= *Operculina complanata*?) have been detected in this newer series of rock fragments.

The following annual reports were read and referred to the Publication Committee:—

REPORT OF THE RECORDING SECRETARY.

The Recording Secretary respectfully reports that during the year ending November 30, 1884, thirty-two members and twenty-two correspondents have been elected.

Resignations of membership have been received and accepted, on the usual conditions, from J. Henry Simes and John Shallcross.

The deaths of eleven members and six correspondents have been announced. As these have been duly recorded in the Proceedings under the date of announcement, the names are not here repeated.

Thirty-three papers have been presented for publication, as follows: N. A. Randolph, 2; Miss S. G. Foulke, 2; David S. Jordan, 1; Angelo Heilprin, 2; Theo. Gill, 2; Seth E. Meek and Robert Newland, 2; Seth E. Meek and David K. Goss, 2; Seth E. Meek, 1; Seth E. Meek and Martin L. Hoffman, 1; Andrew J. Parker, 1; Benjamin Sharp, 1; Joseph Swaim and Seth E. Meek, 1; Rev. H. C. McCook, 1; Thomas Meehan, 1; Otto Meyer, 1; Rafael Arango, 1; Eugene N. S. Ringueberg, 1; Jos. Willcox, 1; Edw. Potts, 1; Henry J. Carter, 1; Frederick D. Chester, 1; D. G. Brinton, 1; Henry F. Osborn, 1; Herman Strecker, 1; Asa Gray, 1, and F. Lamson Scribner, 1.

These have all been printed in the Proceedings.

One hundred and twenty-eight pages of the Proceedings for 1883, and two hundred and sixty-four pages of the volume for 1884, have been printed and distributed, the latter being illustrated by six plates. Eighty-five pages of the Journal have also been published, completing the first part of the ninth volume. These pages contain the conclusion of A. J. Garrett's paper on Society Island Mollusca, illustrated by two lithographic plates, containing one hundred and fifty-two figures, and a valuable paper by Professor Heilprin, on the Tertiary Geology of the Eastern and Southern United States, illustrated by a colored map. The Publication Committee has recently been compelled by lack of means to decline a contribution to the Journal of a valuable paper, notwithstanding the fact that a series of beautiful illustrative plates were offered free of expense, except for printing.

Twenty-two foreign societies have been added to the exchange list, making now a total of 335 societies and journals, to which the numbers of the Proceedings are sent by mail as they are issued. Fifty-two of these receive also the Journal. Letters applying for deficiencies, and proposing exchange of publications as noted in the report of the Librarian, have been productive of the most gratifying returns.

The average attendance at the meetings during the year has been twenty-seven. Verbal communications have been made by twenty-six members; they have been for the most part published in the Proceedings.

The most important event in the history of the Academy during the past year, was the passage of an amendment to the charter by means of which the Society is empowered to hold a larger annual income than heretofore. The preliminary step to the securing of such an amendment was taken by the meeting held December 4, 1883, when the following preamble and resolutions were adopted by a unanimous vote:—

WHEREAS, The limit of the yearly income of the Academy of Natural Sciences of Philadelphia, fixed by the charter at eight thousand dollars, is, in the opinion of the members, insufficient for the necessary requirements of the corporation, therefore—

Resolved, That the officers of the Academy of Natural Sciences of Philadelphia be, and they are hereby authorized and empowered and requested to petition in due form the proper Court in Philadelphia, under the Act of Assembly of Pennsylvania, entitled "An Act to provide for the incorporation and regulation of certain corporations," approved the 29th day of April, A. D. 1874, to so amend the charter of said corporation as to enable the Academy to hold a much larger income, as follows, to wit: By striking out, in the proviso to Section I of said Charter, after the word "income," the following words—"of such estate shall not exceed eight thousand dollars, nor," and insert in lieu thereof the following words, "from the real estate shall not exceed twenty thousand dollars; nor shall the income of the corporation"—so that the proviso to said Section I, as amended, shall read as follows: "*Provided*, That the annual income from the real estate shall not exceed twenty thousand dollars; nor shall the income of the corporation be applied to any other purpose than those for which this corporation is formed."

After the required formalities had been complied with, the consent of the Court to the amendment applied for was announced to the Academy at the meeting held January 22, 1884, and at the following meeting, the thanks of the society were tendered, by resolution, to Mr. Uselma C. Smith, its solicitor, for his services in securing such action.

Chapter I, Article 6, and Chapter XVI, Article 4, of the By-Laws were amended by the meeting held October 28, as reported at length under that date on page 261 of the Proceedings.

On January 29, resolutions providing for an increase of the building fund of the Academy, were adopted, and on February 19 a committee, consisting of Dr. W. S. W. Ruschenberger, Dr. Chas. Schaffer, Mr. Geo. W. Tryon, Jr., Prof. Angelo Heilprin, and Dr. Horace F. Jayne, with power to increase the number, was appointed to carry the resolutions into effect.

Resolutions expressive of the Academy's interest in biological instruction, and urging the desirability of the endowment of biological professorships in connection with the Society, were adopted February 26.

At the meeting held March 18, a communication from Dr. William Pepper, proposing the establishment of a Biological Institute, to be under the joint control of the University of Pennsylvania and the Academy, was referred to the Council for consideration and report. While the subject was still under consideration, and before the Academy was called upon to take definite action upon it, a letter was received from Dr. Pepper acknowledging, on behalf of the Trustees of the University, the courtesy with which their former communication had been received, but expressing the belief that "it is, for the present at least, wiser for the University to pursue independently the development of the special field of biological work and teaching devolving upon her." Further consideration of the desirability of the proposed joint government was thereupon suspended, and the operations of the Academy's Committee on Instruction were carried on independently, as set forth in the reports of the several professors herewith presented.

Dr. Benjamin Sharp was elected Professor of Invertebrate Zoology January 29, and delivered his inaugural lecture on February 3.

Dr. D. G. Brinton was elected Professor of Ethnology and

Archæology February 26, and opened his course in a lecture delivered before the Academy April 4.

The resignation of Dr. J. Gibbons Hunt as Professor of Microscopic Technology was received and accepted May 27. His successor has not yet been appointed.

At the meeting of the Council held November 24, Mr. Jacob Binder was appointed Curator of the Wm. S. Vaux Collections, to serve, in compliance with the Articles of Agreement, during the ensuing twelve months. Mr. Binder accepted the position and declined receiving a compensation for his services. A resolution expressive of the Academy's appreciation of Mr. Binder's efficient discharge of the duties of his position during the past year, was adopted by the meeting held November 25.

During the meeting of the American Association for the Advancement of Science, held in September, the museum and library of the Academy were visited by many of the attending members, and by representatives of the British Association. The Academy is to be congratulated on having been able to add materially to the interest of the important occasion, both by the extent of its library and museum, and the receptions and excursions given under the auspices of its Botanical, and Biological and Microscopical Sections. The generous support given by the citizens of Philadelphia to the Local Committee, in its endeavor to provide fittingly for the meeting referred to, is an encouraging indication of an intelligent interest in science, and consequently in the welfare of the Academy and kindred institutions.

All of which is respectfully submitted,

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The duties of the Corresponding Secretary, as defined by our laws, show very little variety from year to year. It is, however, gratifying to note that the number of societies with which we are in correspondence shows a notable increase. The transmission of our publications by mail, begun last year, places us in closer relation with foreign societies; many of them have agreed to reciprocate, while a few prefer the old method of trans-[illegible]n, for reasons which have been read at various times.

It being the duty of the Corresponding Secretary to acknowledge all gifts to the Museum, the usual circulars have been signed, and the Curator-in-charge, to whom the addresses are generally known, has sent them to the donors. A full account of the donations will appear in the Curator's report.

During the year ending November 30, there have been twenty-two correspondents elected, to all of whom notification has been promptly forwarded, and, excepting to those very recently elected, the diploma has also been sent. Of the correspondents elected during the present and past year, seventeen have acknowledged their election, many having at the same time transmitted valuable publications.

Official notification has been received of the death of Joachim Barrande, Quintino Sella and Sven Nilsson, correspondents.

While the number of letters from societies, etc., does not indicate the entire number receiving our publications, it may be interesting to note that nineteen are from societies, libraries, etc., in North America and Mexico, two from South America, and fifty-three from the Eastern Hemisphere. The entire number of letters, announcing the receipt of our publications, during the year is one hundred and nineteen.

Letters of transmission, with which foreign societies usually accompany their publications, have diminished during the year, owing probably to the transmission of the publications by mail. These letters number forty-four.

The activity of our Librarian, in endeavoring to supply deficiencies in our library, usually induces a corresponding demand on us from our corresponding societies. Letters of this character are noted to the number of nine.

Letters of a miscellaneous nature—in response to our invitation to exchange by mail, regarding deficiencies for which we have applied, announcing anniversary festivities—have been received from foreign societies, numbering nineteen.

In addition to the above, a considerable number of trivial letters have been received, and, where necessary, replied to, mostly entirely unimportant, and often of a purely personal nature.

Respectfully submitted,

GEO. H. HORN, M. D.,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

During the twelve months ending November 30, 1884, 34 additions have been made to the library, an increase of 419 ov the growth of 1883. These additions have consisted of 480 v umes, 2760 pamphlets and parts of periodicals, and 182 ma sheets, photographs, etc.

They have been derived from the following sources:—

Societies,	1856	Engineer Department, U. S. A.	
Editors,	866	U. S. Fish Commission,	
I. V. Williamson Fund,	520	Navy Department,	
Authors,	280	Geological Survey of New Zealand,	
Dr. G. E. Abbot,	145	War Department,	
Wilson Fund,	37	Trustees of British Museum,	
Department of the Interior,	29	Smithsonian Institution,	
Geological Survey of India,	19	Ex. of Wm. S. Vaux,	
Geological Survey of Sweden,	17	Commissioners of Inland Fisheries,	
Russian Geological Commission,	16	F. G. Schaupp,	
Dr. F. V. Hayden,	15	East Indian Government,	
Northern Transcontinental Survey,	14	Geological Survey of Roumania,	
Geological Survey of Belgium,	12	Census Commission of Buenos Aires,	
Geological Survey of Kentucky,	10	W. H. Dougherty,	
Minister of Public Works, France,	8	Department of Mines, Nova Scotia,	
Department of Agriculture,	8	Royal College of Surgeons,	
H. B. M. Government,	8	Justin Winsor,	
Treasury Department,	7	Trustees of Indian Museum,	
Prof. Angelo Heilprin,	6	Brazilian Museum,	
Second Geological Survey of Pennsylvania,	6	Dr. A. E. Foote,	
Dr. R. J. Dunglison,	5	Chas. E. Smith,	
Geological Survey of Canada,	4		
J. H. Redfield,	4		

The departments of the library, to which these additions we distributed, and the proportions of such distribution, are follows:—

Journals,	2382	Helminthology,	
Geology,	250	Education,	
Anthropology,	166	Voyages and Travels,	
General Natural History,	103	Mammalogy,	
Conchology,	82	Agriculture,	
Botany,	55	Encyclopedias,	
Anatomy and Physiology,	53	Bibliography,	
Entomology,	51	Ichthyology,	
Medicine,	45	Mineralogy,	
Chemistry,	40	Geography,	
Physical Science,	28	History,	
Ornithology,	21	Miscellaneous,	

In consequence of the necessary curtailment of appropriatio been done during the year. It is to be hop

that a permanent Binding Fund may be soon placed at the disposal of the Library Committee. While the estimate for binding is, properly enough, one of the first to be curtailed when expenses have to be reduced, yet our rapidly increasing sets of journals and the many valuable illustrated books which reach us in parts as issued, are in danger of being injured or rendered incomplete while used in the unbound form.

The card catalogue of periodicals has been completed, and will be transcribed in the form of a hand catalogue for the greater convenience of those consulting this, perhaps the most important, department of the library. Occasion was taken as the catalogue progressed to make careful memoranda of deficiencies. 243 letters have been written applying for lacking parts and volumes of incomplete sets of journals now in our possession, and 59 proposing exchange with societies, the publications of which are not represented on our shelves at all. The responses to these letters have been of such a satisfactory character as to account, perhaps entirely, for the excess of additions over the number reported at the last annual meeting.

In recording the completion of the important work noted, it gives me pleasure to acknowledge the efficient service of Mr. Emanuele Fronani, of whose assistance I have again been enabled to avail myself during the summer months.

The catalogue of the library, may be now said, for the first time in many years, to be complete. Care is, of course, taken to add the titles of accessions immediately on their presentation.

The portrait of the late Dr. Robert Bridges, which was approaching completion when my last report was presented, has been placed in its proper position in the gallery of Presidents, and is considered an unusually satisfactory likeness. The Academy is indebted for it to Messrs. Geo. W. Tryon, Jr., W. S. W. Ruschenberger, Thos. Meehan, Jos. P. Hazard, J. H. Redfield, Jacob Binder, C. S. Bement, Harrison Allen, John Ashhurst, Jr., Edw. S. Whelen, Chas. Schaeffer, Aubrey H. Smith, John S. Haines, Samuel Lewis, Geo. H. Horn, John Welsh, Chas. E. Smith, Jos. Wharton, Isaac Lea, and George Vaux.

In view of the amount of work accomplished and the results thereof, the past year, in this department of the Academy, may be regarded as an unusually prosperous one.

All of which is respectfully submitted,

EDW. J. NOLAN,

Librarian.

REPORT OF THE CURATORS.

The Curators present the following statement of the Curator-in-charge, Professor Angelo Heilprin, as their report for the year ending November 30:

Work in the various departments of the Museum, has during the past year, as in previous years, been largely of a volunteer nature, but, for this reason, none the less systematic, nor less valuable to the Academy.

The Conchological, Entomological and Botanical departments, under direct control of the Conchological, Entomological and Botanical Sections of the Academy, have benefited almost exclusively from services of this kind, and the same is true of the Mineralogical department covered by the Wm. S. Vaux trust. The Academy feels itself under deep obligation to the special conservators who have so generously contributed their time and labor to the interests of the institution.

In departments other than those here indicated work has not been neglected, but, unfortunately, because of the limited means at the disposal of the Curators, and for general want of space, which together constitute an almost insuperable obstacle to the proper care and exposition of the vast, and still rapidly increasing, collections of the institution, not so much has been accomplished as might have been desired.

The entire series of alcoholics has been carefully overhauled, and the necessary disposition of alcohol toward the preservation of these perishable objects made. The collection may be said to be in a fairly good condition. The recent mammalia have all been redetermined and relabeled, and arranged according to the most approved systems of classification. In this department, the Academy is seriously deficient, and it is to be hoped that at no very distant day the numerous gaps that everywhere occur may be filled in. A complete catalogue has been prepared, showing the Academy to possess just 400 species and varieties, represented in all by 904 specimens.

In the department of Ornithology comparatively little has been accomplished; the accessions have been very limited, as, indeed, they have been for a number of years past. Although the collection of birds still ranks as one of the most complete, and in some respects, the most complete of any in the world, following

immediately after the collections of the British Museum, the National Museum of Vienna, and the University of Leyden, it has of recent years attracted but few students or specialists to its cases, a deplorable condition, doubtless due in great part to imperfect arrangement (incident to the want of a special curator) and the circumstance of the 35,000 or more specimens being mounted, instead of in the far more serviceable form of skins. The absolute necessity of having a specialist, whose services should meet with fit pecuniary compensation, in this, as in all other departments, cannot be too strongly insisted upon. Long neglect of a department means, practically, its collapse, at least so far as the advantages to be derived from it by special students are concerned, and unless it can be adequately supported, must ultimately, by its occupancy of space and the use of time in its preservation, become a drag rather than a spur to the institution of which it forms a part. Despite the general richness of the ornithological collection, it has, through want of adequate means for its support, suffered to such an extent that at the present time it lacks no less than about 170 species or varieties of North American birds alone!

The Conchological department, on the other hand, which has for two decades enjoyed a constant supervision from the part of a distinguished conchologist, is singularly complete, and both in the number and variety of its forms, stands unsurpassed by any similar collection, whether in this country or Europe. It comprises no less than 150,000 specimens, mounted on upwards of 42,000 tablets, and it alone, of all the various departments, represents the actual state of a zoological science as we now know it.

During the year a selection of birds from the general collection has been laid aside to complete a special collection illustrative of North American ornithology.

The work of re-arranging and classifying the geological and paleontological specimens has made considerable progress.

The "local collection," intended for the illustration of the natural products of the States of Pennsylvania and New Jersey, is, as far as the resources of the general collection would permit, complete, except in the department of entomology, for which no suitable cases have as yet been provided. A cabinet of the minerals belonging to the same geographical area has recently been placed in the Museum for the benefit of students. It is

intended to further complete this department by a serial exposition of the rock masses about Philadelphia, and by the preparation of a relief map illustrative of the geology of the city and its immediate surroundings.

The work of labeling and mounting the Wm. S. Vaux collection of minerals, comprising upwards of 6412 specimens, has been completed; a report of progress in this department, prepared by the special Curator, Mr. Jacob Binder, is herewith appended.

One of the most striking accessions made to the Museum during the past year, is the collection of insect and aranead architecture, deposited by one of the Vice-Presidents of the Academy, Dr. H. C. McCook. It is, doubtless, the most complete of its kind in this country, and may be considered to be, in many respects, unique. A valuable collection of fishes from the southern and western waters of the U. S., made by Prof. D. S. Jordan and Mr. Seth E. Meek, has been added to the Ichthyological department.

Various alterations have been made during the current year in the ground floor of the Academy building, but these require no special consideration. Specimens from the Museum have been loaned for study to the Smithsonian Institution, to Prof. James Hall, of Albany, Prof. R. P. Whitfield, of New York, Prof. W. B. Scott, of Princeton, and Mr. Dobson, of London, who have severally rendered service to the Academy by the redetermination or description of the forms that passed through their hands.

The Academy has during the year benefited through the services of five Jessup Fund beneficiaries, who, apart from their studies, have in various ways coöperated with, or assisted, the Curator-in-charge, who hereby acknowledges his thanks. The Curator-in-charge also takes this opportunity of acknowledging his special indebtedness to Mr. Alan F. Gentry, who, during the greater part of the year, has most efficiently acted as his assistant.

Very respectfully,

ANGELO HEILPRIN,
Curator-in-charge A. N. S.

JOSEPH LEIDY,
Chairman Board of Curators.

SUMMARY OF THE REPORT OF WM. C. HENSZEY, TREASURER,

FOR THE YEAR ENDING NOV. 30, 1884.

CR.

Salaries, Janitors, etc.	$3319 93	
Freight	42 70	
Repairs	271 71	
Insurance	55 00	
Coal	551 00	
Printing and Binding Proceedings	838 59	
Mounting Plants	4 40	
Printing and Stationery	114 42	
Vials	6 00	
Plates and Engravings	378 00	
Postage	158 94	
Water Rents	28 35	
Newspaper Reports	70 00	
Gas	111 92	
Books	276 79	
Miscellaneous	472 38	
A. Heilprin, Receipts Committee of Instruction	64 00	
H. C. Lewis, Receipts, Committee of Instruction	235 00	
Uselma C. Smith, Solicitor, Expenses securing Amendment to Charter Acad. Nat. Sciences	25 10	
G. D. Camden, Professional fee, Opinion in regard to lands in Tyler Co., W. Va	50 00	
Instruction and Lecture Fund, transferred to this Fund.	150 00	
Life Memberships transferred to Life Membership Fund	500 00	
		$7724 23

DR.

To Balance from last account	$ 226 59	
" Initiation Fees	290 00	
" Contributions (semi-annual contributions)	1602 48	
" Life Memberships	500 00	
" Admissions to Museum	368 35	
" Sale of Guide to Museum	30 00	
" Publication Committee	617 92	
" Fees, Lectures on Palæontology	64 00	
" " " " Mineralogy	235 00	
" Miscellaneous	32 17	
" Interest from Mortgage investment, Joshua T. Jeanes' Legacy	1000 00	
" Wilson Fund. Towards Salary of Librarian	300 00	
" Publication Fund. Interest on Investments	355 00	
" Barton Fund. " " "	240 00	
" Life Membership Fund. " " "	165 00	
" Maintenance Fund. " " "	155 00	
" Eckfeldt Fund. " " "	125 00	
" Stott Legacy Fund. " " "	100 00	
" Interest on Money awaiting Investment	79 28	
		6485 79
Balance overdrawn, General Account		$1238 44

THOMAS B. WILSON LIBRARY FUND.

By Balance per last statement	$222 55
For Books	279 73
Transferred to General Account, toward Salary of Librarian	300 00
	$802 28
Income from Investments	525 00
Balance overdrawn	$277 28

LIFE MEMBERSHIP FUND. (For Maintenance.)

Balance per last Statement	$ 500 00
Interest on Investments	165 00
Life Memberships transferred to this account	500 00
	$1165 00
Transferred to General Account	165 00
To Balance for Investment	$1000 00

BARTON FUND. (For Printing and Illustrating Publications.)

Interest on Investments	$ 240 00
Transferred to General Account	240 00

JESSUP FUND. (For Support of Students.)

Balance per last Statement	$ 595 01
Interest on Investments	560 00
	$1155 01
Disbursed	535 00
Balance	$620 01

MAINTENANCE FUND.

Balance per last Statement	$ 8 14
Interest on Investments	155 00
Thos. P. Cope, deceased. Legacy	1000 00
R. G. Curtin, M. D. Subscription	5 00
	$1168 14
Transferred to General Account	155 00
To Balance for Investment	$1013 14

PUBLICATION FUND.

Income from Investments	$ 355 00
Transferred to General Account	355 00

ECKFELDT FUND.

Income from Investments	$ 125 00
Transferred to General Account	125 00

I. V. WILLIAMSON LIBRARY FUND.

Balance per last Statement		$ 770 41
Rents Collected		1000 00
Ground-rents Collected		936 58
Cash received. Principal of yearly ground-rent for 52 $\frac{50}{100}$ Dollars. E. S. Lingo St., 170 feet north of Dickinson St.	$875 00	
Four Months' Interest on same	17 50	892 55
		$3599 44
For Books	$1116 66	
Taxes and Water-rents	195 51	
Repairs to Properties	95 82	
Collecting	96 80	
		1504 79
Balance		$2094 60

$875.00 of the above Balance is to be re-invested.

INSTRUCTION AND LECTURE FUND.

Balance per last Statement	$ 56 00
Transferred from General Account	150 00
	$206 00
Disbursements	63 30
Balance	$142 70

MUSEUM FUND.

Interest on Investments	$ 50 00
Disbursements for Minerals, etc	45 00
Balance	$5 00

VAUX FUND.

Balance per last Statement		$428 84
Income from Investments		650 00
Sale of Cabinet		50 00
		$1128 84
Minerals	$272 71	
Cases	222 40	
Book	8 00	
Models	65 00	
Cards	2 75	
Furniture, etc., for Room	80 68	
		651 54
Balance		$477 30

Mrs. STOTT FUND.

Income from Investment	$100 00
Transferred to General Account	100 00

BOOK ACCOUNT. (Jos. Jeanes' Donation).

Balance as per last Statement	$37 13

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the William S. Vaux collections respectfully reports to the Council of the Academy of Natural Sciences :—

The arrangement and labeling of the minerals are now complete, each of the groups having labels indicating the chemical properties, the proportions in which the elements combine, the degree of hardness and specific gravity of each of the species. They are arranged in thirty-six horizontal and five upright cases. One of the upright cases has been made use of for the purpose of illustrating the six systems of crystallography—the forms of crystallization and the structure of crystals being demonstrated by typical specimens of minerals belonging to each system, and by six glass models, having the axial lines represented by threads of different color. In this case will also be found minerals representing the relative degrees of hardness.

The Archæological collection has been entirely rearranged. All implements, such as axes, celts, chisels, gouges, arrow-heads, pipes, pottery, etc., belonging to the same locality, being placed together. This method was suggested by Professor Putnam, of Cambridge, and Professor Brinton, of our own Academy, and is thought to have advantages for ethnological study. By this method the McBride collection (which is considered of undoubted authenticity), has been placed in the Ohio group.

The localities represented are Ohio, Indiana, Illinois, Michigan, Pennsylvania, New Jersey, New York, Massachusetts, Connecticut, Maine, Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Texas, Missouri, Wisconsin, California, and the Pacific Coast, together with Mexico, Costa Rica, Peru, Switzerland, Denmark and Sweden. There are also a few Roman, Carthagenian and Egyptian specimens. They number in all 2940 pieces.

An alphabetical catalogue of the mineral collection has been made, indicating the page and number in Dana, and the case containing the particular specimen.

In my report of November, 1883, the number of minerals was counted by trays, notwithstanding many of them contained more than one specimen. I am informed that this is not the practice

in other museums, either in this country or in Europe, nor does this method do justice to the collection. The same may be said with regard to the Archæological part.

The present method is based on the actual number of specimens, without regard to the number of trays, and is as follows:—

Mineral specimens,	6,391	
Crystallographic models,	6	
Models of historical diamonds,	15	
		6,412

representing about 500 species.

It may be of interest to members of the Academy to know the whole number of minerals contained in the Museum of the Academy (though not strictly in the line of this report); with the assistance of Mr. W. W. Jefferis, the specimens were counted as follows:—

Mineral specimens, Academy proper,	9,633
Lithological specimens, Academy proper,	1,301
Total,	10,934
W. S. Vaux collection,	6,412
Total,	17,346

It will be remembered that, according to terms of the agreement upon which this collection was accepted by the Academy, all specimens purchased from the fund provided for increase, were subject to the approval of the Curators of the Academy in conjunction with the Curator of the collection.

In making purchases, such specimens only have been bought—

1. As represent new species.
2. Species not represented in the collection.
3. Species representing new localities.
4. Such as are superior in character to those already in the collection.

Sixty specimens have been purchased during the year 1884, as follows:—

Minerals,	32
Indian relics,	7
Crystallographic models,	6
Historical diamond models,	15

The collection has been visited by a large number of persons during the past year, many of them professional mineralogists,

especially during the recent meeting of the American and British Association for the Advancement of Science. I have been much gratified to hear expressions of admiration of the collection, many of the specimens being pronounced unique in their character, and not represented in the museums of Europe.

In conclusion, I embrace the opportunity of thanking those of my friends who have expressed a warm interest in my work, and have aided me with valuable suggestions. I take the liberty of making special mention of Dr. Leidy, Mr. W. W. Jefferis, Clarence S. Bement, and Dr. W. S. W. Ruschenberger.

Very respectfully submitted,

JACOB BINDER,

Curator.

REPORT OF THE MICROSCOPICAL AND BIOLOGICAL SECTION.

During the past year, eighteen stated meetings and one public exhibition were held.

The average attendance of members was about fifteen.

At the exhibition given in September to the visiting members of the American Association for the Advancement of Science, a very large audience was present, and the display of microscopes and objects excelled all previous ones, both in number and in scientific importance.

During the year, Dr. N. A. Randolph, Dr. Benjamin Sharp, and Joseph Mellor were elected members.

Edward S. Campbell, Hugo Bilgrim, and Sara Gwendolen Foulke were announced as contributors.

Dr. J. H. Simes and Prof. H. C. Lewis resigned membership.

Dr. Robert E. Rogers died.

Among the more important contributions by members during the year, were :—

A lecture, December 17, 1883, by Dr. M. B. Hartzell. Subject—The Bacteria.

February 4, 1884, by Dr. Benjamin Sharp. Subject—Section Cutting.

March 17, by Mr. W. N. Lockington. Subject—The Fishes of North America and the West Coast.

April 21, by Dr. Sharp. Subject—The Eye of the Invertebrates.

May 5, by Dr. J. G. Hunt. Subject—Fertilization in Some Plants.

May 9, by Dr. Hunt. Subject—The Bioplasm of the Cell.

June 2, by Dr. Geo. A. Rex. Subject—The Myxomycetes of Fairmount Park.

Respectfully submitted,

ROBT. J. HESS, M.D.,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during the past year, the Academy has, as heretofore, continued to publish such papers upon the subject of the Mollusca as have been approved by its Publication Committee.

One member and seven correspondents have been elected. We have no deaths to report; neither has there been any change made in the By-Laws governing the Section.

From the eighteenth annual report of Mr. Geo. W. Tryon, Jr., Conservator, we find that during the year ending December 1, 1884, sixty donations of mollusks and shells have been received from thirty-one persons. The number of trays and labels thus added to the collection is 1126, of specimens 5224; larger accessions in both cases than for several previous years. The Conchological Museum now contains 42,448 trays and written tablets, with 151,015 specimens.

The most important accession of the year is a remarkably fine suite of shells, collected last winter by Mr. Henry Hemphill, on the West Coast of Florida. Most of the specimens are in much finer condition than those previously in our Museum, from the same region; many of them, hitherto known as West Indian, are now first ascertained to inhabit our coast, and not a few are new species. During the last summer, at the instance of Mr Wm. G. Binney, Mr. Hemphill explored the mountains of North Carolina for Helices, collecting a number of rare and fine specimens, of which, by Mr. Binney's generosity, we have obtained a share. This winter Mr. Hemphill is again spending on the Florida Coast, southward of his last year's operations, and arrangements have been made by which we shall receive a series of his collections.

A very complete suite of the shells of our national capital were presented by Mr. F. Lehnert.

Three donations of foreign shells are of unusual interest, namely: From E. Marie, a series of the shells of the island of Guadeloupe, W. I.; from Andrew Garrett, eighty-four species of land shells of the Society Islands, including all the types figured in his paper on this molluscan province, recently published by the Academy; from Dr. S. Archer and the Conchological Section, over three hundred species of marine shells, collected by Dr. Archer at Singapore. Another box, just received from Dr. Archer (contents not yet presented), will bring up our representation of the Singapore mollusks to upwards of five hundred species.

A detailed list of the additions to the Museum accompanies this report (see Curator's report).

The re-arrangement of the Conchological Museum steadily progresses. During the year, the Pleurotomidæ, Terebridæ and Cancellariidæ of the marine gastropods have been carefully studied, and, to a considerable extent, re-labeled and mounted. A commencement has also been made with the series of Pulmonata, by the re-arrangement of the Testacellidæ, Oleacinidæ and Streptaxidæ.

Our Museum cases have become so overcrowded that the display of all the species, under glass, is no longer possible; in many instances, the trays of specimens are piled up several tiers in height, so that the under rows cannot be seen. Unless better and more ample accommodation for the shell collection is soon provided, it may become necessary to withdraw portions of it from exhibition, in order to afford space for the display of the larger and more important specimens.

At the annual meeting of the Section, held on the 4th inst., the following officers were elected:—

Director,	W. S. W. Ruschenberger.
Vice-Director,	John Ford.
Recorder,	S. Raymond Roberts.
Secretary,	John H. Redfield.
Treasurer,	Wm. L. Mactier.
Conservator,	George W. Tryon, Jr.
Librarian,	Edward J. Nolan.

Respectfully submitted, on behalf of the Section,

S. RAYMOND ROBERTS,
Recorder.

REPORT OF THE ENTOMOLOGICAL SECTION.

During the year 1884, the Entomological Section has held its regular monthly meetings, dispensing as usual with those of July and August. The attendance has been fair, but by no means so large as is desirable. It was found that several members had been prevented from attending the Section, owing to other engagements. To remedy this, and with a hope that the change would be beneficial, by accommodating more persons, the Section, at its meeting held December 8, voted to change the time of meeting from the second Friday night to the fourth Monday night of each month, commencing January, 1885. The failure to secure additions to the membership has been very discouraging to the members of the Section, and it is earnestly hoped that the members of the Academy will assist in increasing the number.

The collections under the supervision of the Section, are at present in quite good condition. Much work has been done in the way of disinfecting and arranging the specimens. In an entomological cabinet this requires constant watchfulness, and cannot be dispensed with. The thanks of the Section are due to Mr. S. F. Aaron for much of this work.

Additions to the collection during the past year have been quite small. This has been principally owing to the fact, that those members generally most active in collecting, have been compelled by other more pressing calls, to defer such work to the future.

In connection with the American Entomological Society, there have been published, during the year, articles upon Entomology, amounting to 335 pages of printed matter, together with 9 plates. In addition, there has been printed a biographical sketch of John L. Le Conte, M. D., late Director of the Section, written by S. H. Scudder, also posthumous papers of the same gentleman, edited by Dr. Geo. H. Horn, comprising in all 68 pages, making a total of 403 printed pages. These entomological contributions continue to maintain the high standard of the journal in which they appear.

At the meeting held December 8, the following were elected officers of the Section for the year 1885 :—

Director, ...	Geo. H. Horn, M. D.
Vice-Director, . . .	Rev. Henry C. McCook, D. D.
Recorder, ...	James H. Ridings.
Treasurer, ...	E. T. Cresson.
Conservator, . . .	Henry Skinner, M. D.

Respectfully submitted,

JAMES H. RIDINGS,

Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section has to report to the Academy that the affairs of the Section are in a generally prosperous condition.

Our Herbarium, already one of which the Academy is justly proud, has been increased in new species 407 the past year, without including the additions among the lower cryptogams. The excellent progress made in other matters, under the superintendence of the Conservator, Mr. John H. Redfield, is set forth in detail in his annual report to the Section, which is submitted herewith as part of the Section's report.

Meetings have been held regularly every month, except July and August, the average attendance for the whole year being slightly larger than last.

The Section is free from debt, and has a considerable balance in its treasury.

One of the events of the year was the social re-union and entertainment, in the hall of the Academy, of the botanists in attendance on the meeting of the American Association for the Advancement of Science, under the auspices of the Section. The expense was borne by the members of the Section, without any draft on its regular funds, or on the funds of the Local Committee of the Association. It is believed that the result will be useful to the Academy, in making the work of the botanical department better known, reacting in the interest of botany everywhere.

At the meetings of the Section many matters of interest to botanists have been presented, and some, by Professor Gray, Professor Rothrock, and Messrs. Meehan and Scribner, deemed of sufficient general importance to appear in the Proceedings of the Academy.

The officers elected for the ensuing year are:—

Director, . . . Dr. W. S. W. Ruschenberger.
Vice-Director, . . Thomas Meehan.
Recorder, . . . F. Lamson Scribner.
Cor. Secretary, } . . Isaac C. Martindale.
Treasurer, }
Conservator, . . . John H. Redfield.

Respectfully submitted,
THOMAS MEEHAN,
Vice-Director.

Conservator's Report for 1884.—The Conservator has, during the past year, continued to direct his attention to the care and improvement of the Academy's Herbarium, so far as was compatible with the demands on his time and labor occasioned by receiving, preparing and placing new accessions. With some assistance from Mr. Scribner, certain portions of the North American Herbarium have been mounted, mainly of genera more especially needing this care, such as *Viola*, *Polygala*, *Lupinus*, *Dalea*, *Astragalus*, *Oxytropis*, *Potentilla*, *Eriogonum*, and others. Mr. Burk is now engaged in the work of re-arranging the North American Compositæ after Gray's New Synoptical Flora. In the General Herbarium the provisional alphabetical lists of species have been carried forward as far as Loranthaceæ. These lists, imperfect and defective as they are, will justify the labor expended upon them, by the time saved to every one consulting the Herbarium. It is hoped that this merely preliminary work will soon be completed, and prepare the way for more deliberate and careful elaboration by expert botanists.

During the latter part of the summer our work had to be temporarily suspended by the necessary preparations for receiving the members of the American Association for the Advancement of Science at its September meeting in this city, and the gratification expressed by them on the visits to the Academy's library and herbarium, for the fraternal fellowship extended by our Section, is a source of satisfaction to us all.

The donations of plants during the past year amount to 3183 species, of which 407 are new to our collection. In these donations are included three Centuries of Ellis' North American Fungi, of which a large proportion are probably new to us, and

should be added to the above 407. The North American species received have been 1792, from tropical America were 3, and from the old world 1388. Among the additions may be specified 1057 species, mostly European and North African, from the fine Herbarium of Geo. Curling Joad, presented by Dr. Gray. Though the most of these duplicated species which we already possessed, yet being choice specimens, collected and ticketed by eminent botanists, they greatly add to the value of our working material, while about one-tenth of them were previously unrepresented on our shelves. Our fellow-member, Mr. Canby, who, it will be remembered, was in charge of the Botanical Department of the Northern Transcontinental Survey, during the years 1882 and 1883, in the interest of the Northern Pacific R. R., has contributed a very valuable suite of the collections made by himself, and by Scribner, Brandegee, Tweedy and others under his direction, along the northern border of Western North America, in the Territories of Dakota, Montana and Washington. This series comprehends 851 distinct species of which about 90 were new to us. Our Vice-Director, Mr. Meehan, has also given us the result of his herborizations along the coast of Washington and Alaska Territories, during the summer of 1883, in a collection of 207 species, which, however add only five species to our earlier Alaskan collections received from Kellogg, Harrington, Dall, and others. Other smaller but valuable donations, will be detailed in the Academy's Donation List for 1884.

In large collections, where constant accessions, during a long period of years, have repeatedly duplicated species, there is always a tendency to exaggerated estimates of the number of *species* represented. In regard to the Academy's Herbarium, the estimates have been so vague and so evidently excessive, that the Conservator has been led to undertake an actual enumeration. This apparently simple task is really attended with many difficulties, one of which consists in the varying views of botanists as to the specific validity of forms. In some families this diversity of opinion is so great as to materially affect total results. In such cases, the Conservator has endeavored to follow the authority of the latest leading specialists. Another difficulty arises from the large amount of unworked and unnamed material, which has accumulated since the early days of the Academy, some of it probably duplicating the named species.

The enumeration is not yet complete, but, as it covers about three-fourths of the collection, a tolerably fair estimate may be made of the remainder, on the basis of space occupied. The conclusion is that the phanerogamic species will not exceed 24,000. To these we must add the ferns—1018, by count —and the remaining vascular crygtogams, estimated at 120 species, and we have a total of phanerogams and vascular cryptogams of a little more than 25,000 species. Of the extent of the collection of lower cryptogams, embracing mosses, liverworts, lichens, algæ and fungi, the Conservator is at present unable to give any estimate.

Respectfully submitted,

JOHN H. REDFIELD,

Conservator.

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The meetings of the Section have been held regularly during the year, but the attendance has not been as large as formerly. There have been, however, satisfactory additions to the collections of minerals and rocks, in part by purchases made with the funds of the Section.

Respectfully submitted,

THEO. D. RAND,

Director.

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports, that during the year he has delivered a course of lectures on paleontology and physiography, which course, as in previous years, was attended in principal part by teachers from the various schools of the city. A special course of lectures on geology, arranged by request of the Teachers' Institute of Philadelphia, was delivered before the members of that body, with an attendance ranging from one to two hundred. Six field excursions, em-

bracing points of interest in the neighborhood of the city, and extending to the terminal moraine, on the line of the Delaware and Lackawanna Railroad in New Jersey, and the "mountain colonnades" of Orange, were participated in by a fair proportion of the class.

The condition of the collections of the Academy in the department of paleontology has been materially improved during the year, a complete re-arrangement of the fossils of this country having been effected. The work of identifying and labeling has made considerable progress, and it is hoped that in a short time proper attention may be given to the rich collections illustrating European paleontology as well.

The additions during the year, which are recorded elsewhere, have been neither very numerous nor important. A fine series of Oligocene fossils from Germany, comprising nearly 200 species, has been obtained from Dr. Otto Meyer, in exchange for American Tertiary forms. The Academy is also indebted to Mr. Joseph Willcox for an extensive series of the Nummulitic rock of Florida.

Very respectfully,

ANGELO HEILPRIN,

Professor of Invertebrate Paleontology.

REPORT OF THE PROFESSOR OF MINERALOGY.

The Professor of Mineralogy respectfully reports that during the spring months of 1884, he delivered a course of twenty lectures upon the Geology and Mineralogy of Eastern Pennsylvania. The alternate lectures were given in the open air, and consisted of studies in the field at localities of geological and mineralogical interest in the vicinity of Philadelphia. At the close of the course a more extended excursion was taken to Mauch Chunk, Hazleton, and Drifton, where, through the kindness of friends, unusual facilities were offered for studying the geological structure and the methods of mining anthracite coal. A description of the "field lectures," as reported in a daily newspaper, is herewith presented. The average attendance was nearly forty persons, of whom more than one-half were ladies.

The mineralogical collection of the Academy, as shown in the accompanying Curator's report, has received a number of valuable additions. The placing of the minerals of Pennsylvania in a special case will, it is believed, not only be a convenience to visitors, but, as it becomes more complete, will stimulate a search for new mineral localities. The mineralogists of the State are particularly asked to contribute to this local collection.

As in previous annual reports, attention is again called to the need, in this department, of scientific apparatus, both for the purposes of teaching and for the prosecution of original research. A lithological microscope, a reflecting goniometer, and a Groth's universal apparatus for polarized light, are among the instruments most urgently needed.

Respectfully submitted,

H. CARVILL LEWIS,

Professor of Mineralogy.

REPORT OF THE PROFESSOR OF INVERTEBRATE ZOOLOGY.

The Professor of Invertebrate Zoology respectfully reports that during the past year, since March, when he was placed in office, he has delivered his inaugural address on "The Study of Biology in Germany" (March 10), and six lectures on "Elementary Histology," with demonstrations.

He further reports that the collections under his charge have greatly increased, especially by the addition of a superb collection of marine sponges from the western coast of Florida, presented by Mr. Joseph Willcox. The collection was described by Henry J. Carter in the Proceedings.

A course of some twenty lectures is intended to be given in the early part of the coming year (January, February and March), the subject being "Some of the Principles of Zoology."

Very respectfully,

BENJAMIN SHARP,

Professor of Invertebrate Zoology.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

A short course of lectures on some points in general ethnology was delivered by me, immediately after my appointment as professor in April last. The subjects were :—

Prehistoric Man in America.
The Origin of the Aryan Nations.
The Progress of American Linguistics.
The Civilization of Ancient Mexico and Peru.

These lectures were public and were reasonably well attended.

After the organization of the Bureau of Scientific Information had been established, I forwarded a circular to a considerable number of persons interested in my branch, in different parts of the United States, announcing both the professorship and the Bureau, and asking them to favor the Academy with such specimens and information as would be of advantage to instruction in this department. A number of promises to do so have been received.

There has been but small increase in the collections in my department since I took charge of it. The arrangement of the cabinet leaves much to be desired, but I see no remedy for this, unless considerably more space were at my disposal, and I am well aware that the Academy is unable at present to supply this. I can obtain "for deposit" with the Academy, several very fine local collections of antiquities, were sufficient space for their proper display, and the usual guarantees of conservation, offered their owners.

Very respectfully,

D. G. BRINTON, M. D.,
Professor of Ethnology and Archæology.

The election of Officers for 1885 was held, with the following result:—

President, . . .	Joseph Leidy, M. D.
Vice-Presidents, . .	Thomas Meehan,
	Rev. Henry C. McCook, D. D.
Recording Secretary, .	Edward J. Nolan, M. D.
Corresponding Secretary,	George H. Horn, M. D.
Treasurer, . . .	Wm. C. Henszey.
Librarian, . . .	Edward J. Nolan, M. D.
Curators, . . .	Joseph Leidy, M. D.
	Jacob Binder,
	W. S. W. Ruschenberger, M. D.
	Angelo Heilprin.
Councillors to serve three years, ...	Chas. P. Perot,
	J. H. Redfield,
	S. Fisher Corlies,
	Charles Morris.
Finance Committee, . .	Isaac C. Martindale,
	Clarence S. Bement,
	Aubrey H. Smith,
	S. Fisher Corlies,
	George Y. Shoemaker.

ELECTIONS DURING 1884.

MEMBERS.

January 29.—John Struthers, Thomas M. Fenton, M. D., H. W. Stelwagen, M. D., D. G. Brinton, M. D., Miss Helen C. D. Abbott, William Thomson, M. D., Rev. Wayland Hoyt, D. D., Benj. R. Smith.

February 26.—Eugene W. Fiss, Francis E. Emery.

March 25.—Albert S. Bolles, Ph. D., R. W. Fitzell, Joseph W. Griscom.

April 29.—J. L. Forwood, M. D., Lewis Woolman, John Eyerman, Edward Jackson, M. D., Miss S. D. Atkinson, E. J. Wheelock.

May 27.—Henry N. Rittenhouse.

June 24.—Lieut. Thos. L. Casey, U. S. A.

August 26.—Ralph W. Seiss, M. D., Edw. P. Bliss.

September 30.—Miss Adele M. Fielde, Henry F. Osborn, J. Wanamaker.

October 28.—H. La Barre Jayne, Edmund J. James, Ph. W. B. Scott, George Fales Baker.

November 25.—W. Henry Grant, Rufus Sargent, M. D.

CORRESPONDENTS.

January 29.—Karl A. Zittel, of Munich; August Daubrée, Paris; Marquis de Gaston de Saporta, of Aix; Quintino S of Rome; Albert Gaudry, of Paris.

March 25.—Ludwig von Graff, of Aschaffenburg; E. Renev of Lausanne; G. Dewalque, of Liege; Hans Bruno Geinitz Dresden; Henry N. Moseley, of Oxford; J. T. Burdon Sanders M. D., of London.

April 29.—Ernest André, of Gray, Haute Saone.

October 28.—G. Vom Rath, of Bonn; George E. Dobson London.

November 25.—John Ball, of London; Wm. Carruthers London; Rud. Leuckart, of Leipzig; Anton Dohrn, of Nap H. Grenacher, of Halle i. S.; Alex. Götte, of Rostock i. Ludwig Will, of Rostock i. M.

ADDITIONS TO THE MUSEUM.

ARCHÆOLOGY, ANTIQUITIES, IMPLEMENTS, ETC.—Joseph Leidy. Fragment of Druid stone. Avebury, Eng.
Stuart Wood. Contents of an Indian shell-heap, Indian River, Fla.
Miss A. M. Fielde. Earrings of native work, Laos.
H. Beates. Aboriginal urn, Clearfield Co., Pa.
J. Willcox. Indian implements, Hernando Co., Fla.
Marquis de Nadaillac. Paleoliths, Ras-el-Oued, Tunis, Africa.

MAMMALIA (recent and fossil).—W. P. Buck. Double-headed fœtal pig (*Sus scrofa*).
Phil. Zool. Society. *Macrorhinus angustirostris* (skull), Coast of California; *Cercopithecus albogularis*, Africa.
J. B. Betts. *Condylura cristata*, New Castle, Del.
Mr. Kochusperger. 8 mammalian skulls; antlers of *Cariacus Virginianus*; horns of *Rupicapra tragus*, *Tamias striatus*, *Scalops aquaticus*; skull of *Cariacus Virginianus*, *Ovis aries* (2); horns of *Bos bubalus*, and *Ovis aries*; human skull.

BIRDS.—Stuart Wood. Skeleton and eggs of *Pelecanus fuscus*, from Florida; skeleton of *Colymbus torquatus*; *Tachypetes aquila*.
Mr. Kochusperger. 39 bird skulls, *Corvus Americanus*, *Melanerpes erythrocephalus*, *Porzana Carolina*, and 12 birds' nests.
G. Cochran. *Didunculus strigirostris*, Samoa.
H. England. Embryo pigeon showing five toes.
J. Ford. Nest of *Vireo olivaceus*, Phila., Pa.

REPTILES AND AMPHIBIANS (recent and fossil).—Capt. Livermore. 20 species of amphibians and reptiles from the valley of the Rio Grande.
Harrison Allen. *Anolis principalis*, Fla.
I. Reiff. *Eutænia sirtalis*, Phila., Pa.
E. A. Sturge. *Lygosoma brachypoda*, Petchaburi, Siam.
J. Border. Vertebræ of *Mosasaurus* and crocodile; tooth of *Hyposaurus*, and fragments of turtle bones, Mullica Hill, N. J.
A. F. Gentry. *Eutænia sirtalis*, *Ophibolus doliatus*, *Aromochelys odoratus*, *Rana clamitans*, *Rana palustris*, Phila., Pa.
Wortman and Gentry. *Eutænia sirtalis*, *Storeria Dekayi*, and *Spelerpes ruber*, Phila., Pa.
J. Hazard. *Liopeltis vernalis*, Peacedale, R. I.
E. W. White. *Ceratophrys ornata*, pampas of Buenos Ayres, S. A.
H. Skinner. *Diemyctilus miniatus*, *Diemyctilus viridescens*, Adirondack and Catskill Mountains, N. Y.
Unknown. *Phrynosoma platyrhina* and *Phrynosoma Douglassi*, Humboldt River, Nev.; *Phrynosoma Douglassi*, locality unknown.

FISHES (recent and fossil).—E. F. Halliwell. *Diodon hystrix*, Barbadoes. *Halocypselus evolans*.
J. Jeanes. *Xiphotrygon acutidens*, Eocene of Green River, Wyoming.
A. F. Gentry. *Pomotis aureus*, *Rhinichthys atronasus*, *Boleosoma Olmstedi*, Phila., Pa.
Wortman and Gentry. *Prionotis lineatus*, Coast of N. J.
N. S. Schuyler. *Lagocephalus lævigatus*, Barnegat Bay, N. J.
J. Ford. *Siphostoma fusca*, Somers' Point, N. J.
Prof. Porter. Fish, sp.? Warren Co., N. J.
Mr. Kochusperger. *Hippocampus Hudsonius*, *Pristis antiquorum*, *Sphyrena zygæna*, *Siphostoma fusca*.
B. Sharp. *Amphioxus lanceolatus*, Bay of Naples, Italy.

ARTICULATES (Crustaceans, insects, arachnids, and myriapoda, recent and fossil).—Joseph Leidy. *Eupagurus pollicaris*, Atlantic City, N. J.; *Eupagurus pollicaris* in *Natica* and *Fulgur*, Atlantic City, N. J.; *Libinia canaliculata*, Atlantic City, N. J.

J. Ford. *Ocypoda arenaria*, Atlantic City, N. J.

H. Skinner. Cocoons of *Actias Luna*, *Callosamia angulifera*, and *Platysamia Columbia*; chrysalids of *Papilio Turnus*, *Papilio troilus*, *Papilio asterias*, and *Saturnia Io*, Phila., Pa.

H. C. Brick. *Belostoma grandis*, Phila., Pa.

W. Y. Heberton. *Limulus polyphemus* (2), Cape May Point, N. J.

Mr. Beck. Trap of *Tarantula*.

H. Kingsbury. Case of insects, Blair Co., Pa.

Purchased. Casts of *Asaphus megistos* (Trilobite), showing impression of legs.

MOLLUSCA (recent).—S. F. Aaron. Five species of land shells from Texas.

Rafael Arango. Fifteen species of land, fresh-water and marine shells from Cuba, New Guinea and New Hebrides; five marine species from Cuba; four species from Cuba (types of descriptions).

S. Archer. One hundred and twenty-five species of marine shells collected by him at Singapore.

W. G. Binney. Six species terrestrial shells from N. Carolina, and five species from Georgia; seventeen species from the mountains of Western N. Carolina.

Mrs. A. E. Bush. *Helix ramentosa*, Gould, and *H. pulchella*, Müll. (introduced), from California.

Conchological Section. Sixty-six marine species collected at Singapore by Dr. S. Archer; three hundred and five trays of marine, land and fresh-water shells from Florida, Texas, etc., collected by Henry Hemphill; one hundred and twenty-five species marine shells from Singapore; ten species of land and fresh-water shells (from C. F. Ancey, Marseilles).

John Ford. *Littorina irrorata*, Say, South Atlantic City, N. J.; egg cases of *Fulgur carica* and *F. canaliculata*, Brigantine Beach, N. J.; *Solen ensis*, L., Cape May, N. J.; *Cytherea convexa*, Say, Atlantic City, N. J.; *Donax fossor*, Say, and *Petricola pholadiformis*, Lam.; *Bulimus*, from Syria, *Cingula minuta*, Totten, Providence, R. I.; *Mactra solidissima*, Chemn., young, So. Atlantic City, N. J.; *Gemma Manhattensis*, Prime, Narragansett Bay, R. I.; egg cases of Nassa, and *Petricola pholadiformis*, Lam., Sea Isle City, N. J.; *Solen ensis*, L., with animals, and nidus of *Natica duplicata*, Say, Somers' Point, N. J.; fine specimen of *Turbinella scolymus*, Bahamas; *Natica duplicata*, Say, Atlantic City, N. J.; *Fulgur canaliculata*, Say, Anglesea, N. J.; *Mactra solidissima*, Chemn., and *Zirphæa crispata*, L., from same locality; *Arca pexata* and *Natica duplicata*; egg cases of *Fulgur canaliculata*, attached to valve of *Mactra*; all from Anglesea.

Isaiah Greegor. Seven marine species from the Bahamas; *Bulima intermedia*, Cantr., Florida; *Nerita peleronta*, L. Bahamas. Three marine species from Florida, and two species from the Bahamas.

Andrew Garrett. Eighty-four species of Terrestrial Mollusca, types figured in his paper on the Shells of the Society Islands, published in the Journal of the Academy, vol. ix.

W. D. Hartman. *Achatinella Sowerbyana*, and two other species of *Achatinella*.

F. L. Harvey. Seven species of fresh-water shells, Arkansas.

Henry Hemphill. Six species of Pleurotomidæ, from Florida.

Benton Holcomb. Seven species fresh-water shells, Connecticut.

J. A. Holmes. *Marginella roseida*, Redfield, from an Indian burial mound N. Carolina.

Jos. Leidy. *Columbella lunata*, Say, Atlantic City, N. J.

E. Lehnert. One hundred and twelve trays, shells of Washington, D. C.
E. Marie. Forty five species of shells from Guadeloupe, W. I.
Isaac Massey. *Ranella pulchra*, Japan.
Wesley Newcomb. *Bythinella Monroensis*, Fraunfeld, Florida Springs, Florida.
C. R. Orcutt. Thirty-four species, California; three marine species, Lower California.
G. H. Parker. *Ommastrephes sagittatus*, N. Jersey; ten marine species, vicinity of Boston, Mass.
W. H. Rush. Wood bored by *Xylotrya fimbriata*, from Chesapeake Bay.
A. W. Robinson. *Helix bucculenta*, Gould, Norfolk, Va.
Mrs. Benj. Sharp. *Mya arenaria*, Linn., Nantucket, Mass.
Benj. Sharp. *Mercenaria violacea*, Schum., Nantucket; eleven marine species from the Mediterranean Sea; *Limax agrestis*, Linn., Germantown, Pa.
U. C. Smith. *Unio complanatus*, Solander, from branch of Maurice River, near Vineland, N. J.
F. E. Spinner. *Murex adustus*, Linn., from Bahamas; four species of Unionidæ, from New Hampshire.
L. H. Streng. *Cerithium ocellatum*, Brug., Panama; *Planorbis bicarinatus*, Say, Salem, Oregon; two species fresh-water shells from Michigan.
Southwick and Jenks. *Cingula minuta*, Totten, Naragansett Bay, R. I.
Joseph Willcox. Three marine species, and nidimental capsules of *Fasciolaria*, *Ostrea parasitica*, on mangrove branch, all from W. Coast of Florida.
H. C. Wood, Jr. *Bulimus alternatus*, Say, Valley of the Rio Grande, Texas; *Ommastrephes sagittatus*.

MOLLUSCA (fossil).—E. W. Cooper. *Belemnitella mucronata*, Cretaceous, N. J.
C. S. Bement. *Cerithium giganteum*, Fleury, France.
J. Border. Cast of *Arca*, Mullica Hill, N. J.
J. Leidy. *Ostrea Virginica*, *Buccinum undatum*, Atlantic City, N. J.
J. Ford. *Pecten irradians*, *Fulgur carica*, *Fulgur canaliculata*, *Crepidula fornicata*.
In exchange with Dr. Otto Meyer. 170 species of Oligocene shells, from Germany.

WORMS, ECHINODERMS, CŒLENTERATES AND SPONGES (recent and fossil).—J. Ford. *Caudina arenaria*, Atlantic City, N. J.; *Mellita testudinata*, Holly Head City, N. J.; Sponge, Somers' Point, N. J.; *Lepas anserifera*, Atlantic City, N. J.; *Tubularia indivisa* and Annelid, Sea Isle City.
J. Leidy. *Astrangia Danæ*, Atlantic City, N. J.
E. Potts. 12 species of American fresh-water sponges, Philadelphia, Pa.; *Meyenia Leidyi*, Philadelphia, Pa.
C. Wistar. *Serpula dianthus*, Barnegat, N. J.
J. Willcox. Six specimens of Marine Sponges, West Coast of Florida; 70 trays, containing about 50 (?) species of Marine Sponges, W. Coast of Florida.
L. Woolman. *Scolithus linearis*, Valley Forge, Pa.
G. H. Parker. *Botryllus Gouldii*, *Molgula Manhattensis*, *Dactylometra quinquecirra*, Shark River, N. J.
Lieut. Ruschenberger. Sponge, Long Island.
A. H. Smith. *Pentremites pyriformis*, Mammoth Cave, Ky.

INVERTEBRATE FOSSILS, UNCLASSIFIED.—G. H. Parker. 26 species of Cretaceous and Carboniferous fossils, from Texas; 10 species of Carboniferous fossils, Wise Co., Texas.

G. W. Holstein. 8 species of Cretaceous and Carboniferous fossils, fro Texas.
J. Willcox. 15 trays of Oligocene rocks and fossils, West Coast of Fl
T. H. Aldrich. 21 species of Tertiary fossils, from Mississippi.
W. Spillman. 4 species of Eocene fossils and 2 species of Cretaceo fossils, from Mississippi.

BOTANY (recent).—Wm. M. Canby, in charge of Division of Econom Botany of Northern Transcontinental Survey. 1018 species of plant collected in 1883, in Dakota, Montana and Washington Territories l himself, and by F. L. Scribner, T. S. Brandegee and Frank Tweedy; species collected in Maryland and Florida, by J. Donnell Smith.
A. L. Siler, Kane Co., Utah, through Thomas Meehan. 41 species plant from Southern Utah.
Wm. H. Jeffrics, West Chester, Pa. Specimens of *Gentiana campestri* from vicinity of Geneva, Switzerland.
John H. Redfield. 180 species plants, from Atlantic and Pacific State mostly new to Academy's Herbarium; specimens of *Corema Conrad* Torr., from the chief known localities of the United States.
John H. Redfield and Isaac C. Martindale. 9 species plants collected l C. R. Orcutt, on border of Lower California, in 1883, mostly new to tl Herbarium.
Isaac C. Martindale. Ellis' 11th, 12th and 13th Centuries of Nort American Fungi; "Tuckahoe," or "Indian Bread," collected at Kirl wood, N. J., by Joel P. Kirkbride.
Thos. Meehan. *Sesbania punicea* B. and H., cultivated in Southern State *Cuscuta racemosa* Mart., var. *Chiliana* Engelm., growing on Lucerne, i California, with European specimens of same, both received from D Engelmann; 207 species of plants collected by him in British Columbi and Alaska, in 1883; *Aphelandra* ———, from Western Guatemala; 1 species plants, collected in Arizona, by J. G. Lemmon; Male Strobil of *Macrozamia* ———, an Australian Cycad; Specimens of *Halesia tetr ptera* L., from Mr. Meehan's garden, with specimens of an aberra seedling from same plant, to illustrate remarks of Mr. Meehan in Pro Acad. Nat. Sci., for 1884, p. 32.
John W. Eckfeldt. 100 species Lichens, mostly from Pennsylvan mounted and named by himself; 132 species Lichens, from Hawaiia Islands, England, Austria, Sweden, etc., mostly new to Academy' collection.
Asa Gray. 39 species Arctic plants, collected by Dr. John Murdock, a Signal Service Station, Ooglamie, Pt. Barrow, Arctic Sea, lat. 71°; 1 species plants, collected at Copper I., and Behring's Island, Coast c Kamtschatka, by L. Stejneger, in 1882 and 1883; 101 species plant mostly from China, collected by Ford, David, etc.; *Aster novi-Belgii* L and variety, *Aster paniculatus* Lam., and *Aster vimineus* Lam., all fro Massachusetts; 1057 species plants, mostly European, from Herbariu of Geo. Curling Joad.
G. W. Holstein, through Thos. Meehan. 59 species plants, collected i Texas, Arizona and Southern California, in 1883.
L. J. Wahlstedt, of Christianstad, Sweden, through Robert Nordbloem, c Philada. A collection of Scandinavian *Characeæ*, consisting of 31 specie and numerous varieties and forms.
John Donnell Smith, of Baltimore. Md. *Hieracium Marianum*, Willd from Garrett Co., Md., formerly confounded with *H. Gronovii* L., no restored by Gray; 26 species plants, collected by him in southern Unite States, in 1884.
Thos. C. Porter. 19 species plants from New Jersey and Pennsylvania.
H. J. Hunt, U. S. N., of the Arctic Relief Search Party for the survivo of the Jeannette, through Chas. E. Smith, of Philadelphia. 10 specie Arctic plants, collected in 1882, near the mouth of Lena River, Siberi

Aubrey H. Smith. Fruit of *Torreya Californica*, California; Nut of *Areca Catechu*, from S. China.

G. Howard Parker. *Usnea barbata* and *Batrachospermum moniliforme*, both from Hammonton, N. J.

W. A. Kellerman of Manhattan, Kansas. 23 species plants, collected by him in western Kansas.

Mrs. Fanny E. Briggs, Le Centre, W. T., through Thos. Meehan. 6 species plants, from Washington Terr.

Isaac Burk. *Trichinium exaltatum* Buth., Cult., native of Australia; *Gordonia pubescens*, L'Her., and *Halesia diptera*, Willd., both from Bartram's Garden.

Fossil Botany.—S. E. Paschal. Plant impressions, Triassic shale, Buckingham Valley, Bucks Co., Pa.

A. H. Smith. Wood, Gold Run Mine, Cal.

Minerals.—Joseph Leidy. White fluorite, locality unknown.

C. S. Bement. Topaz, beryl, clevelandite, apatite, zircon, montmorillonite, columbite, fluorite and orthoclase, Stoneham, Me.; curved muscovite, Branchville, Conn.

W. W. Jefferis. Melanite garnets, Frascati, Italy; blende, Santander, Spain; pyrite, Lancaster Co., Pa.; sphalerite, Alston Moor, Cumberland, Eng.; pyrite in calcite, Chester Co., Pa.

J. Binder. 9 specimens of granite, Maine.

W. B. Eltonhead. Corundum, Lehigh Co., Pa.; graphite and anthracite in cast iron; arsenio-pyrite, blende and quartz, Dakota; muscovite, Custer City, Dakota.

J. Hartman. Siderite and hematite, millerite in hematite, Antwerp, N. Y.

G. W. Fiss. Columbite, Amelia Court House, Va.

J. Border. Mica schists, from marl-pit, Mullica Hill, N. J.

J. G. Hiestand. Astrophyllite, celestite, barite and calcite, and zircon, Colorado.

J. Lea. Cancrinite, Chester Co., Pa.

H. C. Lewis. Calcite with byssolite, Chester Co., Pa.

W. Hoyt. Chalcopyrite, Chester Co., Pa.; volcanic ash, Krakatoa.

W. H. Bates. Magnetite, Marion Co., N. C.

A. R. McHenry. Pumice, Java Sea, near Krakatoa.

H. J. Smith. Cassiterite, Rockbridge Co., Va.

H. H. Eames. Azurite and malachite, Santa Rita Mts., Arizona; silver in chrysocola, Quijotoa Mts., Arizona; muscovite and uranite, Ash Co., N. C.

J. Struthers. A collection of agates, silicified and opalized woods, landscape and other marbles, fluoites, calcites, quartz crystals and other minerals, from various localitrs.

S. Wood. Fossiliferous boulder, Escuminiac River, Bonaventure Co., Canada.

Mr. Linn. Limonite (ochre), Montgomery, Ala.

P. F. Brown. Vivianite Mullica Hill, N. J.; byssolite in calcite, French Creek, Chester Co., Pa.

D. S. Martin. Coal, Discoe Island, Greenland; turba, Bahia, Brazil.

Mineralogical Section A. N. S. Barite, Cumberland, England; apophyllite and calcite, Chester Co., Pa.; crocidolite, South Africa; vanadinite, Arizona; strengite and cacoxenite, Giessen, Germany; pseudomorphs after sarcolite, Canada; priceite, Oregon; pseudocotonnite, Vesuvius, Italy; vesbite, Vesuvius, Italy; dietrichite, Hungary; struvite, Schemnitz; clausthalite, Sweden; menacannite, var. washingtonite, Litchfield, Conn.; euchlorine, Vesuvius, Italy; muscovite, barcenite, Mexico; bornite, Colorado; schraufite, Bukowina; cubanite, Cal.; kjerulfite and tschermakit, Norway.

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Ueber die Zahl der Zähne bei den Hasenschartenkieferspalten.
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Sur la valeur morphologique de la trompe d'Eustache et les dérivés de l'arc palatin, de l'arc mandibulaire et de l'arc bryoiden des vertebres. 1884. The Author.

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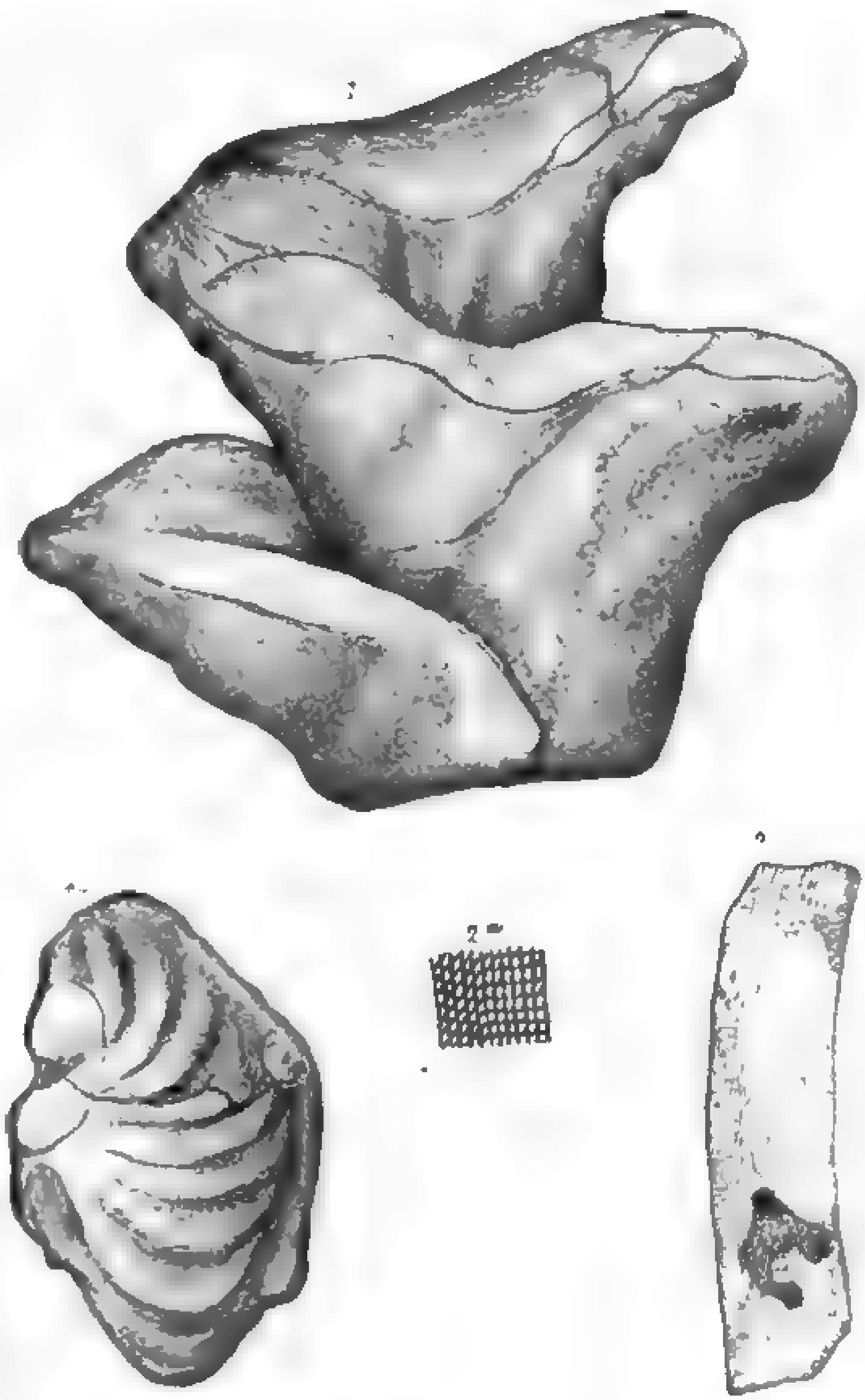

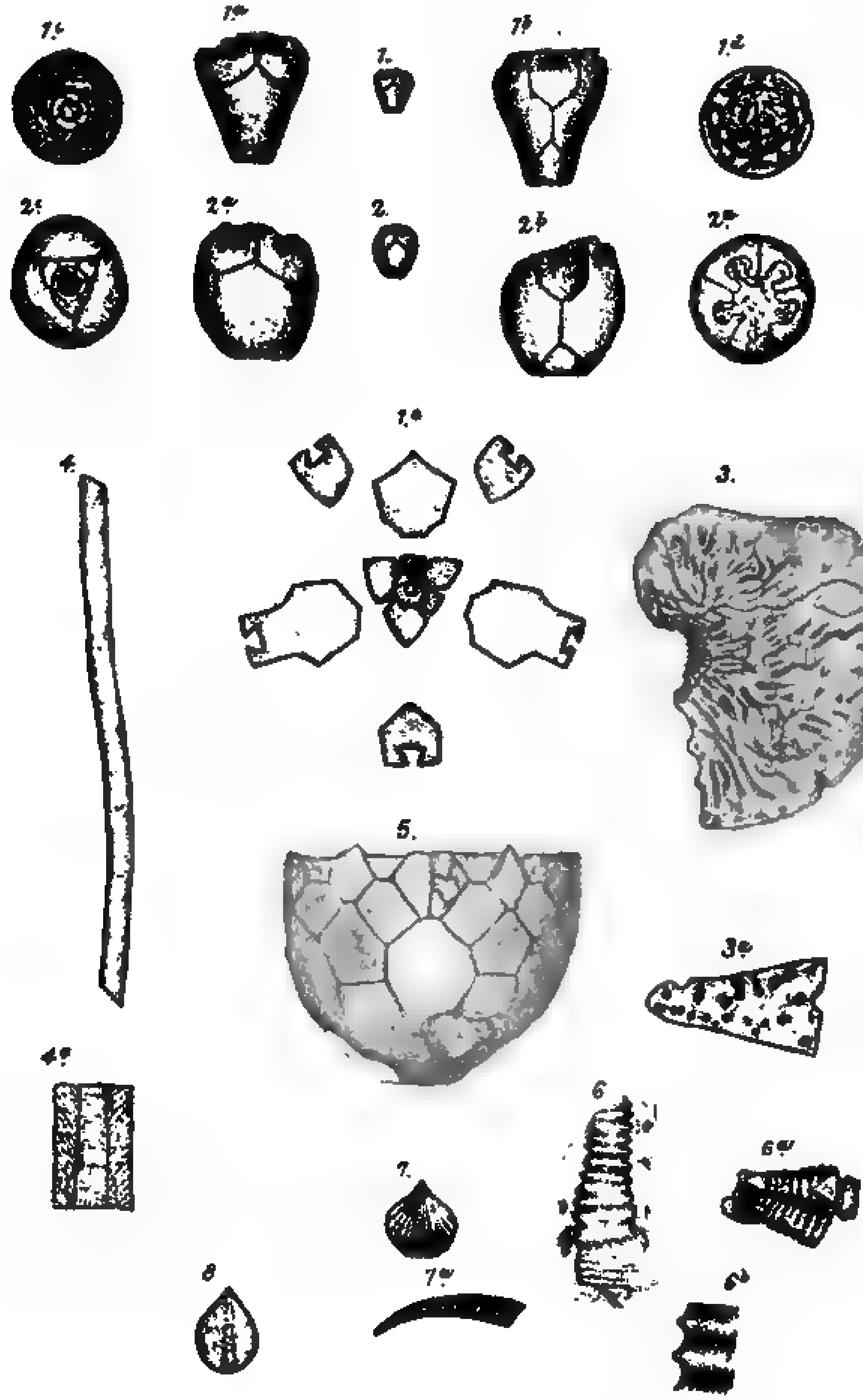
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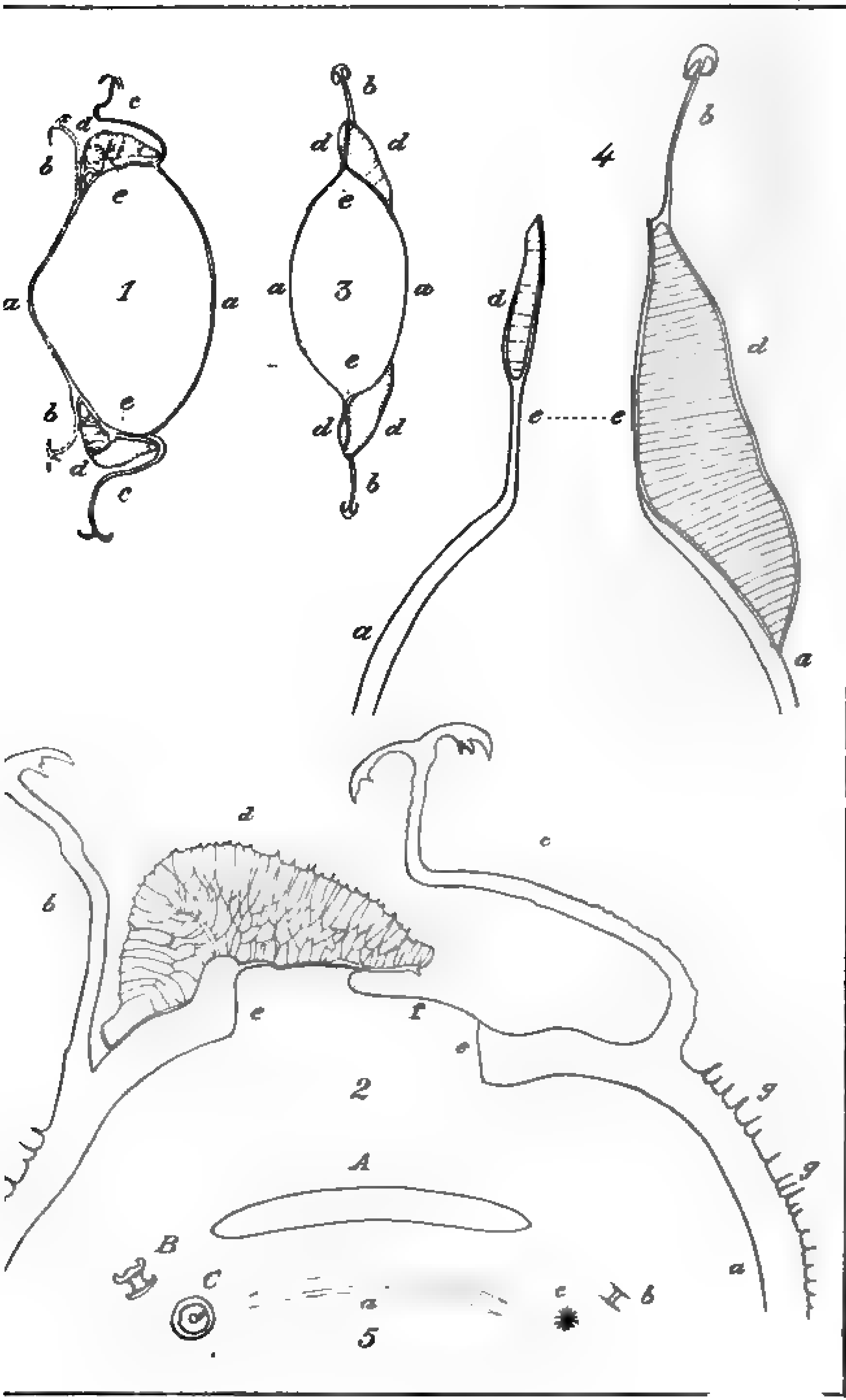

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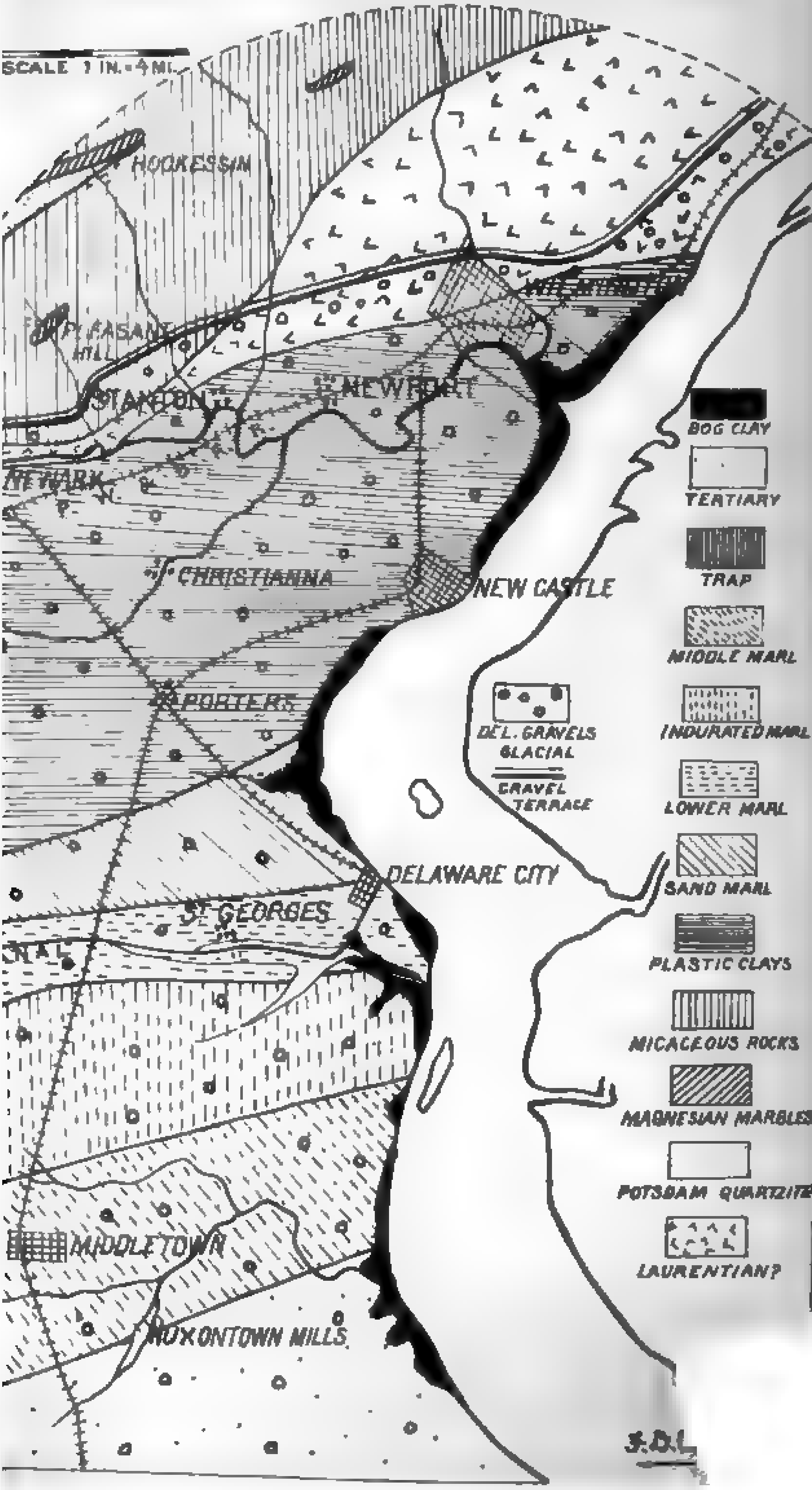
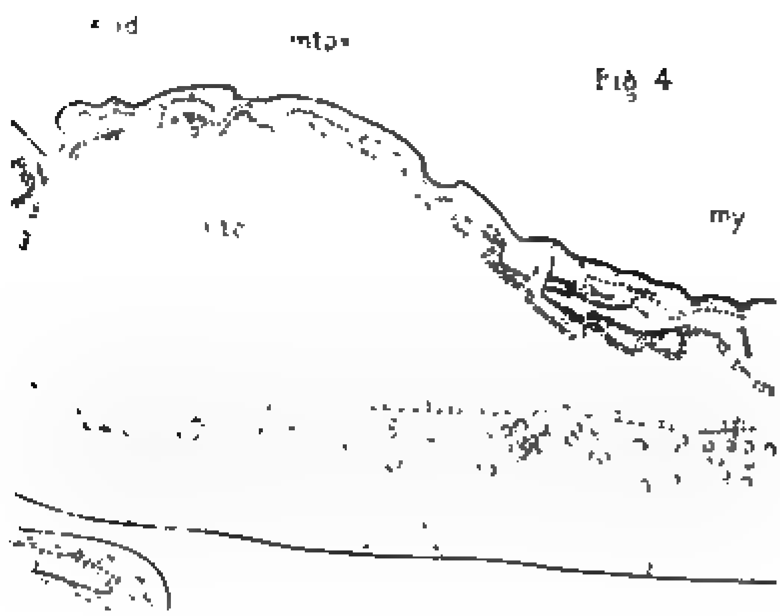
POTTS ON CRISTATELLA, &c.

OLOGICAL MAP OF NORTHERN DELAWARE.





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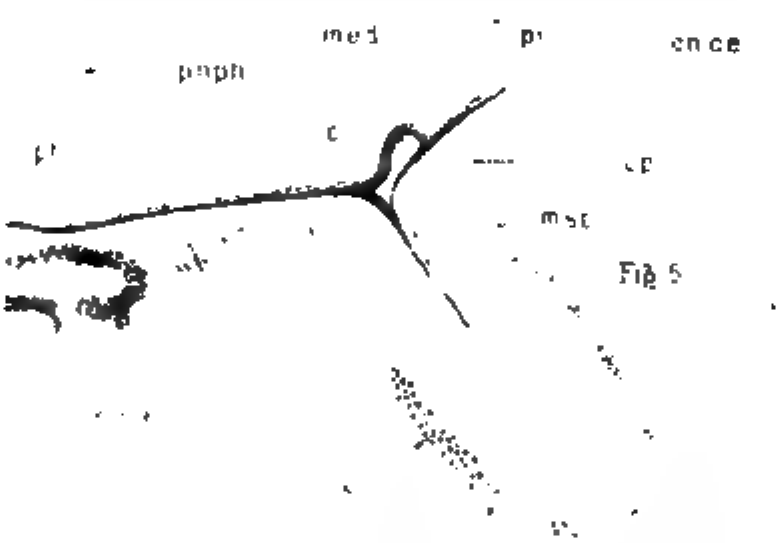

Fig 5

Fig 9

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1885.

COMMITTEE OF PUBLICATION:

JOSEPH LEIDY, M. D., GEO. H. HORN, M. D.,
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JOHN H. REDFIELD.

EDITOR: EDWARD J. NOLAN, M. D.

PHILADELPHIA:
ACADEMY OF NATURAL SCIENCES,
LOGAN SQUARE,
1886.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA,
February 4, 1886.

I hereby certify that printed copies of the Proceedings for 1885 have been presented at the meetings of the Academy, as follows :—

Pages	9 to 24	March 10, 1885.
"	25 to 40	April 7, 1885.
"	41 to 88	April 21, 1885.
"	89 to 96	April 28, 1885.
"	97 to 112	May 12, 1885.
"	113 to 144	June 9, 1885.
"	145 to 176	June 23, 1885.
"	177 to 224	September 1, 1885.
"	225 to 240	September 29, 1885.
"	241 to 272	October 6, 1885.
"	273 to 304	October 13, 1885.
"	305 to 352	November 17, 1885.
"	353 to 384	December 15, 1885.
"	385 to 416	January 19, 1886.

EDWARD J. NOLAN,
Recording Secretary.

PHILADELPHIA
W. P. KILDARE, PRINTER

LIST OF CONTRIBUTORS.

With reference to the several articles contributed by each.

For Verbal Communications see General Index.

PROCEEDINGS

OF THE

ACADEMY OF NATURAL SCIENCES

OF

PHILADELPHIA.

1885.

JANUARY 6, 1885.

Dr. CHAS. SCHAEFFER in the chair.

Twenty-six persons present.

The following papers were presented for publication:—

"On the American Species of the Genus Umbra," by Willis S. Blatchley.

"A Review of the Species of the Genus Semotilus," by Ernest P. Bicknell and Fletcher B. Dresslar.

JANUARY 13.

The President, Dr. LEIDY, in the chair.

Twenty-four persons present.

On some Parasitic Worms of Birds.—Prof. LEIDY stated that Dr. B. H. Warren, of Westchester, much interested in ornithological pursuits, had submitted to his examination a number of parasitic worms obtained in the preparation of specimens. Recently he had sent to him the carcass of a Snow Bird, *Junco hyemalis*, in which he reported a multitude of worms filling the

thoracico-abdominal cavity, and extending into the neck and beneath the skin of the breast and abdomen. From the carcass, seventy-two worms were obtained, of which two-thirds were females ranging from 90 to 120 mm. in length; the rest males, ranging from 40 to 55 mm. From the abdomen of another bird, Dr. Warren obtained five worms, three females from 55 to 90 mm., and two males, 40 and 55 mm. In twenty-two birds examined by Dr. Warren, the parasites were found only in the two indicated. The worms appear to be the *Filaria obtusa* Rudolphi, which infests the *Hirundo rustica*, and other species of European Swallows. The worms of the Snow Bird reach double the length of those of the Swallows, but in other characters agree with the descriptions of *F. obtusa*, as given by Diesing and Dujardin, and also with the figures given by the latter (Hist. Helminthes, pl. iii), except that it is uncertain as to the existence in our specimens of the buccal armature represented by Dujardin. The worms are translucent white, with a chocolate-brown intestine and white uteri and testes. The caudal extremity is obtuse, without appendages, and in the male possesses two spicules, of which the longer curved one is 1·125 mm. long, and the shorter twisted one 0·5 mm. long. The ova, containing developed embryos, are 0·045 mm. long and 0·032 mm. broad.

Six other specimens, apparently also pertaining to *Filaria obtusa*, Dr. Warren obtained from the abdominal cavity partly imbedded in the wall, of a Meadow Lark, *Sturnella magna*. Two are females, 130 and 140 mm. long by 0·625 mm. thick; and four are males, from 50 to 60 mm. long by 0·5 mm. thick.

Six specimens of another *Filaria* were obtained from the abdomen of a female Kingfisher, *Ceryle alcyon*. The species appears to be the *Filaria physalura* of Bremser, described from specimens obtained from several species of Brazilian Kingfishers. Five of the worms are females, ranging from one foot to one foot and a half in length, and from one to one and a half millimetres in thickness. The head is obtuse, and the body gradually tapers to the tail. The mouth is bounded by a pair of small conical papillæ. The five females measure, respectively, 12, 13, 14, 17, and 18 inches. A single male is 35 mm. long by 0·625 mm. thick. The tail is incurved, ends in a minute blunt cone, and is bialate, with the alæ short and quinquecostate. The length of the alated portion is 0·35 mm. The spicule, partially exserted, is recurved. The specimens, when alive, were pink in color, and exhibited a slender chocolate-brown intestine, with large tortuous white uteri.

From the thoracic cavity of a Gray Snipe, *Gallinago Wilsoni*, Dr. Warren obtained five Flukes, 18 mm. long, by 4 mm. broad. These appear to be *Monostomum mutabile*.

From a Whippoorwill, *Antrostomus vociferus*, Dr. Warren obtained four worms, two females of 18 mm., and two males of 12 mm., which appear to be *Ascaris subulata*.

From the Pileated Woodpecker, *Hylotomus pileatus*, Dr. Warren obtained ten worms, which appear to pertain to the *Spiroptera quadriloba* Rudolphi, the female of which was originally described from specimens found in the Green Woodpecker, *Picus viridis*. The specimens are reported as having been found in the abdominal cavity. Six are females from 9 to 12 mm. long by 0·5 mm. thick, and four males 7 and 8 mm. long by 0·375 mm. thick. Body white, nearly equally attenuated towards both ends; transversely wrinkled, and anteriorly minutely, regularly and sharply annulated; mouth quadrilobate. Tail of female conical subacute; tail of male bialate, sexcostate, end acute; spicules two, the longest 1·5 mm. long, the shortest 0·5 mm. long.

The following were ordered to be printed:—

ON THE AMERICAN SPECIES OF THE GENUS UMBRA.

BY WILLIS S. BLATCHLEY.

I have compared numerous specimens of mud-minnows (*Umbra* Müller), from different parts of the United States, with a view of ascertaining whether more than one species exists in our waters. I find, as already noted by Jordan and Bean, two types; the one (*limi*) inhabiting the waters of the great lake region and northwestwardly; the other (*pygmæa*), inhabiting the coastwise streams from Connecticut to North Carolina.

On careful comparison, the only constant difference between these forms, which I am able to appreciate, is the coloration.

The true *Umbra limi* is dull olive-green in color, with about fourteen narrow, pale, transverse stripes, often obscure in the young; dark bar at base of caudal much less distinct, and lower jaw always paler than in *pygmæa*.

The eastern form, which I regard as a geographical subspecies (*Umbra limi pygmæa*), is much darker in color, with about twelve pale, narrow longitudinal instead of transverse stripes, the one beginning at upper angle of opercle being double the width of the others; dark bar at base of caudal very distinct, extending over 1½ scales; lower jaw dark, almost black in adults.

The following is the synonymy of each of the two forms:—

Umbra limi.

Hydrargyra limi Kirtland, Bost. Journ. Nat. Hist., iii, 1840, 277 (Northern Ohio).

Melanura limi Agassiz, Amer. Journ. Sci. Arts, 1855, 217; Packard & Putnam, Amer. Nat., Jan., 1872 (Mammoth Cave); Jordan, Man. Vert., 1st ed., 1876, 253, 2d ed., 1878, and 3d ed., 1880, 265; Jordan, Rept. Geol. Surv. Ind., 1875, 33; Jordan & Copeland, Check List Fresh Wat. Fish. N. A., 1877, 143; Jordan, Bull. U. S. Nat. Mus., ix, 1877, 49 (Ohio Valley); Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 103 (Suamico R., Fox R., Rock R., Wisconsin R., White R.); Nelson, Bull. Ill. Lab. Nat. Hist., i, 43; Jordan, Bull. Ill. Lab. Nat. Hist., ii, 1878, 52 (Johnson and Union Counties, Illinois; Crystal Lake, McHenry Co., Ill.); Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 84 (Ohio and Ill. R. Basins); Forbes, Bull. Ill. Lab. Nat. Hist., ii, 1878, 78 (Food of *Melanura limi*).

Umbra limi Günther, Cat. Fish. Brit. Mus., vi, 1866, 232; Jordan, Proc. Acad. Nat. Sci. Philad., 1877, 44 (Lakes, Laporte Co., Ind.;

St. Joseph's R., Maumee R., Tippecanoe R, White R.); Jordan, Rept. Geol. Surv. Ohio, iv, 1882, 912; Jordan & Gilbert, Synopsis Fish. N. A., 1883, 350.

Hydrargyra fusca Thompson, Nat. Hist. Vt., 1842, 137 (Lake Champlain).

Hydrargyra atricauda De Kay, New York Fauna, Fishes, 1842, 220 (Lake Champlain).

Umbra limi pygmæa.

Leuciscus pygmæus De Kay, N. Y. Fauna, Fishes, 1842, 214 (Tappan, Rockland Co., N. Y.).

Melanura pygmæa Baird, Ninth Smithson. Rept., 1855, 28 (New Jersey Coast); Jordan, Man. Vert., 2d ed., 1878, and 3d ed., 265, 1880; Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 104; Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 84 (James R., Neuse R.).

Umbra pygmæa Bean, MSS.; Jordan, Bull. U. S. Nat. Mus., x, 1874, 58 (Delaware R.); Jordan, Rept. Geol. Surv. Ohio, iv, 1882, 918; Bean, Cat. Fish. International Fish Exhibition, London. 1883, 84 (Kingston, N. C.).

Fundulus fuscus Ayres, Bost. Journ. Nat. Hist., iv, 1843, 296 (Brook Haven, Long Island).

Melanura annulata Agassiz, Amer. Journ. Sci. Arts, 1855, 217 (not *Exoglossum annulatum* Rafinesque).

A REVIEW OF THE SPECIES OF THE GENUS SEMOTILUS.

BY ERNEST P. BICKNELL AND FLETCHER B. DRESSLAR.

In this paper we give the synonymy of the species of the genus *Semotilus*, with an analytical key by which they may be distinguished.

The specimens which we have studied belong to the Museum of the Indiana University, most of them having been collected by Professor David S. Jordan.

SEMOTILUS.

Semotilus Rafinesque, Ichth. Obiensis, 1820, 49 (*dorsalis*.)
Leucosomus Heckel, "Russegger's Reise, 1841, 1042" (*argenteus*.)
Cheilonemus Baird, Storer's History Fishes Mass., 1855, 285 (*pulchellus*.)

Analysis of Species of Semotilus.

a. Origin of dorsal fin about midway between middle of orbit and base of caudal; body rather robust, especially anteriorly. Vertebræ[1] 22 + 20; the interneural spine of first dorsal ray inserted between fifteenth and sixteenth neural spines. A distinct black spot on anterior part of base of dorsal; coloration dusky, little silvery, rosy below in spring.

b. Scales comparatively small, crowded anteriorly, their number about 10–54–7; head large and broad, its length $3\frac{1}{2}$ in head; maxillary barbel very small, indistinct in young specimens; eye small, 6 to 7 times in head (in adult); dusky bluish above, paler below; belly white; size medium, reaches a length of about a foot. *atromaculatus.* 1.

bb. Scales rather large, not crowded anteriorly, their number about 9–48–5; head $3\frac{3}{4}$ in length; maxillary barbel well developed; eye rather large, its diameter about four in head in young; dark bluish above and on upper part of sides, becoming rather abruptly light below lateral line; size small, attains a length of 3 inches or more. *thoreauianus.* 2.

[1] In *Semotilus atromaculatus*. This character has not been verified in *S. thoreauianus*.

aa. Origin of dorsal fin about midway between nostril and base of caudal; scales not crowded anteriorly, their number about 8–45–5; body rather more slender; vertebræ 22+20; interneural spine of first dorsal ray inserted between thirteenth and fourteenth neural spines; head moderate, about 4 in length; maxillary barbel very small; eye high up, about 4½ in head; color bright metallic bluish on upper part of body, becoming white below; no black spot on base of dorsal; size comparatively large, reaching a length of 18 inches. *bullaris*. 3.

1. **Semotilus atromaculatus.** Creek Chub, Horned Dace.

Cyprinus atromaculatus Mitchill, American Monthly Magazine, ii, 1817, 324 (Wallkill R.).

Leuciscus atromaculatus De Kay, N. Y. Fauna, Fishes, 1842, 210, plate xxxii, fig. 102; Storer, "Synopsis Fishes N. A., 1846, 409" (copied).

Semotilus atromaculatus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 204.

Leucosomus atromaculatus Cope, Proc. Acad. Nat. Sci. Phila., 1861, 523.

Semotilus dorsalis Rafinesque, Ichth. Ohiensis, 1820, 49 (Kentucky); Kirtland, "Zoölogy Ohio, 1838, 169;" Kirtland, Boston Journal Nat. Hist., 1841, vol. iii, 184, 345.

Leuciscus dorsalis Storer, "Synopsis Fishes N. A., 1846, 411."

Semotilus cephalus Rafinesque, Ichth. Ohiensis, 1820, 49 (Kentucky); Kirtland, Zoölogy Ohio, 1838, 169; Kirtland, Boston Journal Nat. Hist., 1840, vol. iii, 345.

Leuciscus cephalus De Kay, N. Y. Fauna, Fish., 1842, 214; Storer, "Synopsis Fishes N. A., 1846, 409."

Leuciscus storeri Cuvier & Valenciennes, Hist. Nat. Poissons, vol. xvii, 1844, 319 (N. Y.).

Leuciscus iris Cuvier & Valenciennes, Hist. Nat. Poissons, 1844, vol. xvii, 255, plate 496 (N. Y. and Carolina).

Leuciscus pulchelloides Ayres, "Proc. Boston Society Natural History, 1849, vol. iii, 157."

Leucosomus pallidus Girard. Proc. Acad. Nat. Sci. Phila., 1856, 190 (Antelope Creek, Arkansas); Girard, Pacific R. R. Rept., 1858, 251, Pl. 61, fig. 6; Girard, Proc. Acad. Nat. Sci. Phila., 1858, 251–2 (Antelope Creek, Arkansas).

Semotilus pallidus Cope, Cyprinidæ Penn., 1866, 364 (Platte R.), (no description); Jordan, Manual Vertebrates, 1st ed., 1876, 279.

Leucosomus incrassatus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 251–2 (Near Choctaw Agency); Girard, Pacific R. R. Rept., 1858, 252, Pl. 61, fig. 1 (Near Choctaw Agency).

Semotilus speciosus Girard, Proc. Acad. Nat. Sci. Phil., 1856, 204 (Sweet Water R., Nebraska); Girard, Pacific R. R. Rept., 1858, 283, Pl. 61, fig. 11 (Tributary of Platte River).

Semotilus macrocephalus Girard, Proc. Acad. Nat. Sci. Phil., 1856, 204 (Fort Pierre).

Leucosomus macrocephalus Girard, Pacific R. R. Rept., 1858, 252, Pl. 61, fig. 1 (Fort Pierre).

Semotilus hammondi Abbott, Proc. Acad. Nat. Sci. Phil., 1860, 474 (Kansas).

Semotilus corporalis Putnam, Bulletin Museum Comparative Zoölogy, 1863, 8 (synonymy only, not *Cyprinus corporalis* Mitchill); Cope, Proc. Acad. Nat. Sci. Phil., 1865, 85 (Platte River); Cope, Cyprinidæ Penn., 1866, 363, Pl. 10, fig. 2; Storer, History Fishes Mass., 1867, 256 (near Williams College, no description); Cope, Hayden's Geological Survey, Wyoming, for 1870, 1872, 442, 472 (Platte R.); Abbott, "American Naturalist, April, 1870, 12" (Delaware R.); Jordan, Indiana Geological Survey, 1874, 223; Jordan, Manual Vertebrates, 1st ed., 1876, 277; Jordan, Bulletin Buffalo Society Nat. Hist., 1876, 94; Jordan, Annals Lyceum Nat. Hist. N. Y., 1877, 327, 362, 368, 369, 376 (Ocmulgee R., Etowah R., White R., Ind.); Jordan, Annals N. Y. Acad. Sciences, vol. i, No. 4, 107, 1877 (Housatonic R., Hudson R., Cayuga Lake, Genesee R., Delaware R., L. Erie, L. Michigan, Fox R., Rock R., Peckatonica R., Wisconsin R., Suamico R., White R., Illinois R., Ohio R., Kentucky R., Rock Castle R., Cumberland R., Salt R., Powell's R., French Broad R., Etowah R., Ocmulgee R.); Jordan & Brayton, Bulletin U. S. National Museum, 1878, xii, 26, 38, 54, 68, 80, 86 (Saluda R., Ocmulgee R., Clinch R., French Broad R., Rock Castle R., Alabama Basin, James R., Neuse R., Santee R., Gt. Pedee R., Tennessee R., Ohio R., Illinois R., and other streams); Hay, Proc. U. S. National Museum, 1880, 512 (Catawba Creek, Miss.); Jordan, Manual Vertebrates, 1880, ed. iii, 304; Hay, Bulletin U. S. Fish Commission, 1882 (Big Black R., Miss.); Jordan, Rept. Fishes Ohio, 1882, 863; Jordan & Gilbert, Synopsis Fishes N. A., 1882, 221; Bean, Catalogue Fishes exhibited International Exhibition, London, 1883.

Leucosomus corporalis Günther, Catalogue Fishes British Museum, 1868, 269 (Susquehanna R., Tioga Co., N. Y.; Lake Erie).

Habitat.—Dakota to Western Massachusetts, South to Georgia and Indian Territory, especially abundant in the Mississippi Valley. It is found especially in small brooks in the grass and weeds.

The specimens before us are from near Bloomington, Indiana; Clifty Creek, Ind.; French Broad River, Tenn.; Rock Castle River, Ky.; Rolling Fork, Ky.; Wolf Creek, Ky. We adopt for this species the specific name *atromaculatus*, instead of *corporalis*,

by which it has been usually known, because, in our judgment, the original *Cyprinus corporalis* of Mitchill is *Semotilus bullaris*, as was formerly stated by Dr. Abbott, while the present species is evidently Mitchill's *Cyprinus atromaculatus*.

The following is Mitchill's account of *Cyprinus corporalis*:—

"*Cyprinus corporalis*. This fish is called by the Dutch, Corporalen, or corporal, and inhabits the Hudson in the neighborhood of Albany, the Wallkill through its whole extent, and the western streams and lakes from Wood Creek to the Oneida Lake, and so on.

"The length of a middle-sized individual is about thirteen inches, and the girth five; though he frequently grows larger.

"The head is smooth, roundish, thick, and without scales. The body is thickly covered with scales; on the back, more especially between the head and the dorsal fin, the hue is dusky; on the belly it is uniformly white, and on the sides the forepart of each scale is covered with a blackish film or pigment.

"Mouth toothless, and of a moderate gape; tongue distinct, but not free; gill-covers smooth.

"The tail is forked; the lateral line bends downward, and ends in the middle of the tail.

"The dorsal fin is near the middle of the back, and consists of seven rays; the caudal fin is composed of nineteen rays or thereabout.

"The anal has seven, the ventral seven, the pectorals have thirteen, the branchiostegous membrane has three rays, the dorsal and caudal fins are tipped with a blackish tinge.

"Takes the hook, if baited with dough, when let down through holes in the ice, at midwinter, in the Hudson at Albany; flesh eatable, but rather soft and coarse."

2. **Semotilus thoreauianus.**

Semotilus thoreauianus Jordan, Bulletin U. S. National Museum, x, 63, 1877 (Flint River); Jordan, Bulletin U. S. National Museum, 1878, xii, 43 (Flint River); Jordan & Gilbert, Synopsis Fishes N. A., 1882, 221 (Flint River).

The specimens of this species in the Indiana University Museum were taken by Professors Gilbert and Swain, near Tuscaloosa, Alabama.

The original types were from the Flint River; no others have been reported.

This species is very close to *S. atromaculatus*, differing chiefly in the size of the scales.

3. **Semotilus bullaris.** **Fall-fish, Roach, Dace.**

Cyprinus bullaris Rafinesque, American Monthly Magazine, 1817, 120 (Hudson R).

Semotilus bullaris Jordan, Annals N. Y. Acad. Sciences, vol. i, No. iv, 1877, 108 (Connecticut R., Delaware R., Susquehanna R.); Jordan, Manual Vertebrates, 1878, 304; Jordan & Gilbert, Synopsis Fishes, N. A., 1882, 222.

Cyprinus corporalis Mitchill, American Monthly Magazine, i, 1817, 289 (Hudson R.).

Leuciscus corporalis De Kay, N. Y. Fauna, Fishes, 1842, 213 (copied).

Semotilus corporalis Abbott, Proc. Acad. Nat Sci. Phil., 1861, 152, 154 (Trenton).

Leuciscus argenteus Storer, Rept. Fishes Mass., 1839, 90 (Worcester County).

Leucosomus argenteus Heckel, "Russegger's Reise, 1841."

Semotilus argenteus Putnam, Bulletin Museum Comparative Zoölogy, 1863, 8 (synonymy only); Jordan, Manual Vertebrates, 1876, 278.

Leuciscus pulchellus Storer, Rept. Fishes Mass., 1839, 91 (Walpole, Mass.); De Kay, N. Y. Fauna, Fishes, 1842, 208; Cuvier & Valenciennes, Hist. Nat. Poissons, xvii, 320, 1844.

Leucosomus pulchellus Girard, Proc. Acad. Nat. Sci. Phil., 1856, 189.

Cheilonemus pulchellus Storer, History Fishes Mass., 1867, 286.

Leucosomus pulchellus Günther, Catalogue Fishes British Museum, 1868, vii, 268 (Montreal; Rangely Lake, Me.; Delaware River).

Leucosomus chrysoleucus Heckel, "Russegger's Reise, 1841" (not *Cypr. chrysoleucus* Mitchill).

Leucosomus nitidus De Kay, N. Y. Fauna, Fishes, 1842, 209 (Lake Champlain).

Hybognathus nitidus Girard, Proc. Acad. Nat. Sci. Phil., 1856, 210 (Lake Champlain).

Leuciscus chrysopterus De Kay, N. Y. Fauna, Fishes, 1842, 211 (New York Bay).

Leucosomus rhotheus Cope, Proc. Acad. Nat. Sci. Phil., 1861, 523 (Susquehanna River).

Semotilus rhotheus Cope, Synopsis Cyprinidæ Penn., 1863, 362; Jordan, Manual Vertebrates, 1876, 278.

Leucosomus cataractus (Baird MSS.), Cope, Proc. Acad. Nat. Sci. Phil., 1861, 523 (Susquehanna River).

Squalius hyalope Cope, Proc. Acad. Nat. Sci. Phil., 1864, 280 (Conestoga River).

Habitat.—Southern Canada and Eastern United States, as far south as Chesapeake Bay.

The specimens examined by us are from Massachusetts.

JANUARY 20.

Mr. GEORGE W. TRYON, Jr., in the chair.

Thirty-two persons present.

The death of Prof. Wm. Wagner, a member, was announced.

A paper entitled "Description of a new Colias from the Rocky Mountains, and of an example of Polymelianism in Samia Cecropia," by Hermann Strecker, was presented for publication.

A New Locality for Beegerite.—Prof. GEORGE A. KOENIG placed on record the determination of *Beegerite*, from the "Old Lout," San Juan County, Colorado. This species was described in 1881 by the speaker as $6PbS,Bi_2S_3$, from Park County Colorado. It crystallizes in isometric cubo-octohedrons, with orthorhombic habitus. Only one specimen was then known to be in existence. Since, Dr. F. Genth has examined a specimen, massive, from Summit County, Colorado, which is *Beegerite*, in which 15 per cent. of lead is replaced by as much silver. Some months ago the speaker received among other bismuth minerals from the Old Lout Mine, Colorado. a small specimen of a fine granular, lead-gray mineral, mixed with chalcopyrite, pyrite, barite, and quartz. After a preliminary examination, revealing the peculiar composition of the substance, about 1·2 gram. were selected with great care, but it was not possible to exclude all pyrite and chalcopyrite.

Of this the analysis gave:

Bi	=	19·35
Pb	=	45·87
Ag	=	9·98
Cu	=	1·12
Fe	=	2·89
S	=	16·39
Insoluble	=	0·12
		95·72

If copper, iron, and the corresponding amount of sulphur are eliminated as chalcopyrite and pyrite, the ratio between (Pb_1Ag_2) and Bi is as 5·74 : 2, which, in connection with the loss of 4 per cent. in the analysis, is near enough to the ratio : 6 : 2 to admit of no doubt that this mineral is Beegerite, now known from three localities in Colorado.

JANUARY 27.

Dr. W. S. W. RUSCHENBERGER in the chair.

Twenty-eight persons present.

The deaths of Thomas Clyde, a member, and of Friedrich Ritter v. Stein, a correspondent, were announced.

The following minute was adopted :

The Academy of Natural Sciences of Philadelphia learns with profound regret of the death of Prof. Wm. Wagner, one of its earliest members, whose generous encouragement of scientific pursuits has done much to foster a study of the natural sciences in this country.

Observations on Tenacity of Life, and Regeneration of Excised Parts in Lumbricus terrestris.—Miss Adele M. Fielde remarked that the observations recorded before the meeting held Jan. 6, were made in the laboratory of the Academy of Natural Sciences of Philadelphia. The temperature had been nearly constant at about 60°, and varied only from 55° to 65°. The observations began Nov. 29, 1884. No worm lived more than a few hours when exposed to the air. Worms kept in water, without food, the water changed daily, lived from eleven to fourteen days. It made no apparent difference in the duration of life, whether the worms were kept in darkness or in light.

Eight portions of worms, consisting of from twenty to thirty segments, taken from the posterior end, had lived in earth during the forty days of observation, and though plump, healthful, and with blood of its usual redness, showed no signs of growth at either end. Between the segments, however, new half-segments had been inserted, after a method which ladies in sewing call a gusset. Some of these worms had five such insertions, while no similar half-segments were observed in many worms that were examined, in order to ascertain whether such half-segments existed in whole and healthy worms. These new half-segments appeared at irregular distances apart, between the old segments, on the sides of the portions of worms, and appeared to be a manner of growth not heretofore observed in earthworms regenerating exsected parts.

Nine worms from which the five anterior segments were excised Nov. 29, had been kept in moist earth, with which comminuted leaves of oak and maple were mingled. The brain of the earthworm lies in the third segment, and the first subœsophageal ganglion in the fourth segment, so that the brain and œsophageal collar were removed by the excision. All these worms were living, and a part of them had wholly regenerated the excised segments.

Ten worms, which at the same date lost five anterior and from twenty to thirty posterior segments, were all alive and were regenerating the excised portions.

Eight worms, which at the same date lost their posterior seg-

ments to within ten behind the clitellum, were all living and had regenerated some portion of the excised part.

The manner of regeneration of the excised anterior five segments had been :—

1. A union of the outer coat of the body with the lining of the alimentary canal, roughly healing the wound.

2. A prolongation of these coats, forming a translucent white tube which could be protruded from and retracted into the projecting border of the wound. This tube was at first but a third or a half the diameter of the body.

3. The formation of the lip or proboscis on the superior side of the end of the tube.

4. Segmentation proceeding from the anterior end of the regenerated part backward, until the normal number of segments were reproduced.

5. The deposit of coloring matter in the epidermis of the new segments, and their enlargement to the diameter of the old segments.

Reference was made to the observations published by Dr. Bülow in the "Archiv für Naturgeschichte," 1882.

Miss Fielde now further reports having found a completely regenerated brain, œsophageal collar, and subœsophageal ganglion, all of normal size and in normal site, in earthworms, which had fifty-eight days previous been decapitated at the fifth segment. The worms had been kept in earth, at a temperature of about 60°.

The precautions taken to ensure accuracy in these observations had been, first, a thorough examination of all the earth into which the decapitated worms were put, making it certain that the earth contained no other worms than the decapitated ones; secondly, care that nothing containing earthworms was at any time added to the earth in which the decapitated worms were kept; thirdly, repeated examinations, at intervals of less than a week, of all the earth holding the decapitated worms, and the careful removal of minute worms bred therein; fourthly, frequent counting of the decapitated worms, with examination under a lens, the evident wound constantly showing that the worms under observation were the individuals decapitated. The paler color of the new portions also distinguished these worms from others.

Forty days after decapitation, the excised segments had been regenerated, so as to present an external appearance of completeness, but no brain was visible in dissection. Forty-five days after decapitation the blood-vessels were seen ramifying on the completely regenerated pharynx in a normal manner, but no brain was found. In one of the worms dissected on the fifty-eighth day after decapitation, the subœsophageal ganglion and the œsophageal collar were found to be complete and of the normal size, but the brain lobes were of but half the normal size, and were separated by an interspace of the width of one of the lobes. The blood-vessels united normally on the median line between

the lobes. Another worm decapitated at the same date, though of apparently weaker vitality, had regenerated all the excised portions, and showed a completely formed brain, with lobes of the normal size in contact.

Messrs. Burnett Landreth and J. Addison Campbell, and Mrs. Cornelius Stevenson, were elected members.

FEBRUARY 3.

Mr. GEORGE W. TRYON, Jr., in the chair.

Twenty-seven persons present.

FEBRUARY 10.

Rev. H. C. McCOOK, D. D., Vice-President, in the chair.

Twenty-two persons present.

The Internal Cambium Ring in Gelsemium sempervirens.—Dr. J. T. ROTHROCK, at the meeting of the Botanical Section held February 9, called attention to the internal cambium ring in the stem of *Gelsemium sempervirens.* It might well be designated as the inner cambium. His attention was attracted by the fact that in a *stem* of three-eighths of an inch diameter, the pith was actually less in diameter than in a *twig* of a quarter the size of the *stem.* Microscopic examination showed that in the larger stem there were ordinarily four or more points, at which a well-defined swelling curved inward from the circumference of what should have been the pith-cavity. These swellings resolved themselves when closely examined into:—

1. Toward the centre an imperfectly defined membrane, resembling cuticle, which was not always present.
2. One or more rows of large cells like the parenchyma we find under the epidermal layer.
3. Several poorly defined layers of smaller cells, such as often mark the limits of growth in bark.
4. The frequent presence of bast fibres or of sclerenchyma cells.
5. An evident layer of thin-walled, square cells, closely resembling, though somewhat smaller than those of the external cambium. They showed signs of division, which indicated that they were still a living tissue.

These facts explained at once why the pith was constantly being encroached upon until it at length almost disappeared. The medullary rays dipped down through, and widened out, in

this inner cambium, *inwardly*, just as they did *outwardly*, in the usual form of cambium layer. He also remarked that bast fibres had long been known to exist in the pith of *Tecoma radicans*, and in this case something like an inner cambium would be found, though it is more obscure. *Sambucus Canadensis* also exhibited in the very large stems a smaller pith than in those of moderate size. In this there was nothing comparable to the inner cambium. He also remarked that for the past two winters his attention had been called to the presence of considerable quantities of chlorophyll in the pith of *Lycium vulgare*. This was not confined to the smallest stems, but was found also in those of over a quarter of an inch in diameter, and where of course a considerable belt of hard wood was found between the pith and the outer zone, where chlorophyll is expected. It was also observed in *Lycium* that the chlorophyll was not in the form of bodies but diffused in character, as it is said to be in some infusorians. In *Lycium* the cells of the pith showed, in winter, abundance of protoplasm which had the nucleus on one side and very striking bands extending thence across the cell to the further side.

The following was ordered to be printed :—

DESCRIPTION OF A NEW COLIAS FROM THE ROCKY MOUNTAINS, AND OF AN EXAMPLE OF POLYMELIANISM IN SAMIA CECROPIA.

BY HERMANN STRECKER.

Colias elis.

♀ expands 1⅞ inches; with the exception of the primaries being slightly more pointed apically, of the same shape as *Hecla*, of which species it may probably be a form, as it resembles it closely in many particulars.

Head, collar and antennæ dark pink or rosy; body black with greenish hairs.

Upper surface. Primaries bright orange, with blackish exterior margin of moderate width until towards the costa where it widens considerably; this margin encloses a row of seven ovate lemon-yellow spots or dashes which are rounded interiorly and somewhat pointed exteriorly; the two nearest the costa are much the smallest, the others are nearly uniform in size, though varying a trifle from each other in shape. A black discal spot, small and somewhat linear in one example, and nearly round and of fair size in another. Costa and fringe deep pink. Secondaries are orange, somewhat obscured with black atoms, a submarginal row of yellow spots, not quite as conspicuous as those of primaries, exterior to these at the apex and the apical half of costal and exterior edge, the wing is blackish; a good-sized deep orange or red lead-colored discal spot, round in one example and in another somewhat oblong, or rather the shape produced by a smaller round spot being joined and partly merged into a larger one; fringe same color as on primaries.

Under surface. Primaries orange on disk, with greenish exterior border of same width as the blackish border of upper surface; also greenish along the costa; edge of costa and fringe deep pink. A black discal spot with pale centre. Secondaries green, the inner two-thirds darker, leaving an exterior border of the same color but a shade paler. Costa and fringe as in primaries; discal spot silvery white, ringed with deep pink.

Albinous ♀ form. Upper surface white of greenish yellow tinge, the disk of primaries, especially towards the inner margin faintly suffused with a very pale ochraceous tint. On one example the blackish border and the discal spots are about the same as in the

orange form, on another the spots enclosed by the border of primaries are reduced to mere streaks and on the secondaries there are no traces of the border at all. In all examples of both forms there is a powdering of dark scales on the base of wings and along the inner margin of secondaries interior to the abdominal fold. Under surface as in the orange form, except that the orange of superiors is replaced by yellowish white, and the green of all wings is somewhat paler.

Taken by Capt. Gamble Geddes at an elevation of 10,000 feet, on the summit of "Kicking Horse Pass," in the Rocky Mountains, between Alberta Territory and British Columbia, at the boundary between the United States and the British possessions, about 300 miles north of Montana.

It is an act of temerity to describe a Colias as new under any circumstances in these days, and doubly so to describe it from examples of the female sex alone, yet I have no apprehension that the above insect will not stand as a valid species.

Capt Geddes took about fifteen examples, all females, nine of the orange form, and about six of the white; but nothing that could possibly be considered as the male. The other examples of *Colias* captured in the same locality were lemon-colored males and females probably of one species, and allied to *Pelidne*, but bearing no kinship to the above. The most remarkable and distinctive feature of this *C. elis* is the white female; as the species, I am positive, will be found, whenever the male is discovered, to belong to a group in which albinous females are unknown, its congeners being *Hecla*, *Hela Standingeri* and *Eogene*, species in which no instance of the pale female has yet been known to occur; all of which are found only at great altitudes or at the North Polar Regions and are in the male distinguished from the other red or orange species by the absence of the mealy kidney- or oval-shaped spot on the upper surface of the costa of secondaries near the body.

It is curious, in regard to these albinous females of the Coliades, that in one group they should occur in one species only, whilst in another there should be but one species, *C. Meadii*, found also at great elevation, in which they do not occur; and in yet another species, *C. Vautierii*, of the same group with the last mentioned *Meadii*, found in Chili, the female is always white, such a thing as a red one being entirely unknown.

An Example of Samia Cecropia having a Fifth Aborted Wing.— I have lately received from Mr. Ph. Laurent, of Philadelphia, an example of *Samia Cecropia*, bred by him from a cocoon, having an aborted, or rather the portion of a third primary. It is a male of the ordinary size, expanding about $5\frac{1}{2}$ inches, and is one of those smoky varieties in which the red portion of the transverse bands on wings is very much narrowed. The right primary and both secondaries are normal in shape and marking. The left primary is in length from base to apex exactly the same as is the right; but in width from inner angle across to the costa, it is $\frac{3}{16}$ inch less; the markings are the same, allowing for a little condensing owing to the difference in the width. The venation is normal in all wings; the left primary is also somewhat narrower at the base where it joins the body; the inner margin is in exact line with that of its fellow, thus causing the wing at costa, where it joins the thorax, to be further in from the collar and head than its opposite.

The third primary, or rather portion of a primary, emerges from the side of the collar, and consists mainly of the costal and subcostal nervures, a small part of the median nervure, and a strip of wing about a quarter of an inch wide; but the latter was much curled and twisted in drying, and does not show this width fully. Its length is about two-thirds that of the normal wing with which it runs parallel, but it is in no way visibly connected therewith.

This form of monstrosity is apparently of exceedingly great rarity. I have heard of only three other instances—those recorded by Prof. Westwood in the Trans. Ent. Soc. Lond., 1879, pp. 220, 221, in which three diurnals are described, each possessing a third aborted right-hand secondary. In one of them, an example of *Gonepteryx Rhamni*, the normal right wing is much less than the left, the same with the second example, a *Vanessa Urticæ*, leading to the conclusion in those cases as with the *Cecropia*, that the abnormal wing was produced at the expense of the normal.

In the two cases just cited, the extra wing is joined at the base of the costa to the proper wing; in the third case mentioned by Prof. Westwood, it is apparently a streak or strip, as it were, on the inferior surface of right secondary, distinguished from the

rest of the wing, or the part thereof, by the difference in color and marking alone.

It will be noticed that in the case of the three diurnals, that the extra wing is always a right secondary, whilst in the *Cecropia* it is a left primary.

FEBRUARY 17.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-five persons present.

FEBRUARY 24.

Mr. JACOB BINDER in the chair.

Twenty-one persons present.

A New Fresh-water Sponge from Nova Scotia.—Mr. E. POTTS described a form recently identified by him as follows:—

HETEROMEYENIA PICTOUENSIS, n. sp.

Sponge light green, even when dry, massive, encrusting; texture very compact; spicules non-fasciculated, persistent; surface mostly smooth.

Gemmules very scarce, spherical, crust thick.

Skeleton spicules cylindrical, short, robust, rounded or abruptly terminated; entirely spined, spines conical at the centre of the spicule, elsewhere generally curving *forward*, or towards each extremity. Rounded terminations of spicules covered with short spines, though frequently a single large spine or acute termination is seen at one or both extremities.

Dermal spicules absent or undiscovered.

Birotulates of the longer class surrounding the gemmules, rather numerous, one-half longer than the others; shafts conspicuously fusiform or largest at the centre, where are frequently found one or more long spines. Their rotules consist of three to six irregularly placed rays, recurved at the extremities.

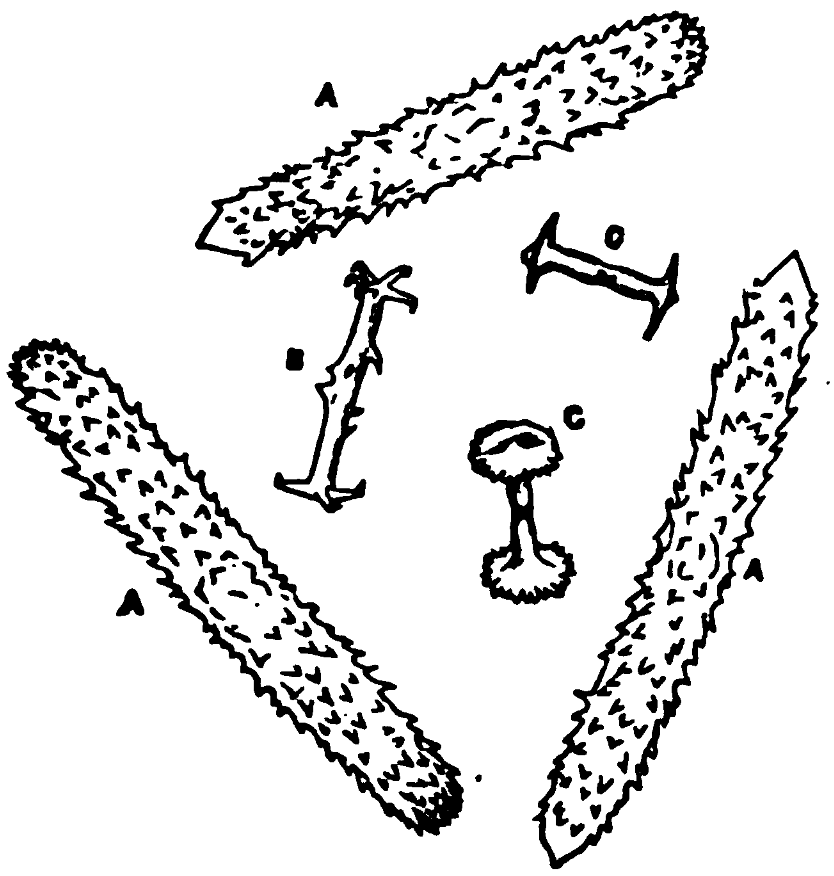
Birotulates of the shorter class abundant and compactly placed around the gemmule; shafts mostly smooth, though sometimes bearing a single spine; irregularly cylindrical, but rapidly widening to support the rotules, which are large, umbonate, nearly flat, and finely lacinulate at their margins; occasionally bearing spines.

Measurements.—Skeleton spicules 0·0075 inch long, by 0·00075 inch thick; length of long birotulates 0·0021 inch; of short birotulates 0·0012 inch; diameter of disc of latter 0·0009 inch.

Habitat.—On submerged wood, etc.

Locality.—Collected only by or for Mr. A. H. McKay, B. A., B. S., of Pictou, Nova Scotia, from several lakes upon the watershed of that region.

This beautiful and interesting sponge was first discovered by Mr. McKay, during the summer of 1884. At that time its novelty, as indicated by its unusually robust, entirely spined skeleton spicules was easily recognized, but the absence of gemmules at that season precluded the determination of its generic relations, and it has continued unnamed. During the last week of December, however, a further search was rewarded by the finding of other "specimens upon sticks pulled up through a break made in the ice," and amongst these a few, and but a few gemmulæ have now been discovered.



A A A. Skeleton spicules; B. Long birotulate; C. C. Short do. Magnified 250 diameters.

These suffice to place it clearly within the genus *Heteromeyenia*, near *H. Ryderii*, while the peculiarities of its birotulates distinguish it from that or any other species.

Mr. Potts called attention to its green and apparently living and growing condition, during midwinter, in that northern latitude, as indicating that like *Spongilla aspinosa*, of the New Jersey swamps, this species also is an "evergreen," continuing its life in the normal state throughout the year, and for this reason not needing to form "protected gemmules" in such abundance as do other species.

At the suggestion of Mr. McKay, to whose enthusiastic search we owe its discovery, the local specific *Pictouensis* has gladly been given to this species.

The following were elected members:—

Charles Harrod Vinton, M.D., Henry Leffmann, M.D., S. Frank Aaron and Edw. Longstreth.

MARCH 3.

The President, Dr. LEIDY, in the chair.

Twenty-seven members present.

The following papers were presented for publication:—

"A Review of the American Genera and Species of Batrachidæ," by Seth E. Meek and Edw. A. Hall.

"A Review of the Species of the Genus Pimephales," by Willis S. Blatchley.

The deaths of Mrs. S. R. Barton, a member, and of John Gwynn Jeffries, a correspondent, were announced.

Spicate Inflorescence in Cypripedium insigne.—Mr. THOMAS MEEHAN referred to a specimen on the table of *Cypripedium insigne*, an orchid from the cooler parts of the East Indies, which had a spike with two flowers and other undeveloped buds, the normal character being a one-flowered scape. These departures from the normal form afforded valuable lessons, though frequently passed over as mere freaks of nature. A spicate inflorescence was a common characteristic in allied species. From the illustration before us, we might infer that the one-flowered kinds were species in which the power to develop a proper spike had been arrested. We might expect to see attempts at this form of inflorescence in *Cypripedium acaule* of our own country.

A very important lesson from these occasional departures had but recently the attention given to it that it properly deserved, and that was that whenever any particular plant departed from its normal form, other characters came into existence, which, in a separate plant would, and often did, obtain for the new departure the rank of a species. In this instance, the second flower on the spike was different from the lower and normal one in the upper segment of the perianth (sepals) having a regular outline. In the normal form it was so crumpled as to present a trilobed appearance. In the normal form the labellum was so elongated as to be three times the length of the column. In the upper flower the labellum was but double the length, giving it a somewhat globular appearance. There were other variations that formed a combination of characters quite sufficient to mark a species if they were constantly produced in a separate state. Why could not this rare occurrence become a continuous one, and thus a new species be formed—created, we may say—out of an older one? There can be no reason. We may call this a freak of nature, but it could not have occurred without that combination of circumstances which we call law. We have no warranty for saying that a law which has operated to produce a departure in a solitary instance like this, might not have a more permanent power at some other time. Nor is there any warranty for believing that a law that has operated as we see here on one plant, might not operate on a hundred, or on all the plants of a district, or even on plants in separate districts widely separated from each other.

In a paper by himself published in the Proceedings of the Troy Meeting of the American Association for the Advancement of Science, " On the introduction of species by sudden leaps," as well

as elsewhere, he had given illustrations of the sudden appearance of identical forms in widely separated localities. If we may generalize from these facts, as we seemed almost warranted in doing, we need not be always looking for the links supposed to be missing, which the belief in the hypothesis of development by slow modifications compelled us to search for, nor need we be reduced to the only alternative of believing that all new species sprang from one parent, which formed a centre of distribution in each particular case. A whole species might be called into existence in the shape of hundreds of individuals or in numerous centres, if only a law that we know from these instances can operate suddenly and exceptionally should continue regularly to act. Such a belief would tend materially to remove difficulties in the way of theories of evolution, that now prevented a full acceptance thereof.[1]

If we can conceive that a suddenly introduced and yet permanently acting force was introduced to operate on some lower beings, the difficulty might be removed. It seemed to him that in some palæontological fields there are evidences of rapid evolution at certain periods, and of greater permanency at others, and this could only be by the introduction of a force equal to the emergency, as in this sudden case brought to the notice of the Academy above.

It would be an interesting study to endeavor to trace the laws that operated in these changes. In this study we must leave behind us impressions which we have imbibed from the idea of mere freaks, hybrids, a return to primitive forms, and other mere guesses with which scientific literature abounds. On the table before us, he observed, are the recent Proceedings of the Royal Society of Tasmania, in which is an account of a remarkable change in a potato, a variety brought from Scotland a few years previously, known as Patterson's Victoria, a variety with white flowers and round white tubers, which, after a culture of a few years in the new climate, produced purple flowers, flat ovate tubers, and these tubers with pink eyes. The members of that society looked at it as a return to the original form of some hybrid variety. We here, with other facts before us, would rather regard it as the effect of environment operating on some innate, and so far unknown, cause of change which might lie dormant through long ages till the peculiar conditions of the environment called them into active life. There seemed in fact seeds for form, as well as seeds for individuals, awaiting the required conditions for germination and rapid growth. In the one case we were able to perceive and appreciate them, except in some of the lowest

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[1] Principal Dawson has suggested that one difficulty in the way of accepting the prevalent theories of the evolution of man, comes from the fact that anthropology affords no "missing link" in the human skull. The oldest hitherto found shows as full a development as in modern man.

organisms. The principle that contained the germ of form was, however, yet as wholly unknown as that of the supposed disease-germs of the atmosphere.

March 10.

The President, Dr. Leidy, in the chair.

Twenty-four persons present.

The following papers were presented for publication:—

"New Genera and Species of Fossil Cockroaches from the Older American Rocks," by Samuel H. Scudder.

"A Revision of the North American Melicæ," by F. Lamson Scribner.

"A Review of the American Eleotridinæ," by Carl H. Eigenmann and Morton W. Fordice.

The deaths of Samuel Powell and Geo. Whitney, members, and of Benjamin Silliman, Jr., a correspondent, were announced.

Rhinoceros and Hippotherium from Florida.—Prof. Leidy directed attention to some fossil remains, recently received from Dr. J. C. Neal, of Archer, Florida, and obtained by him from the same deposit noticed in the Proceedings of 1884, p. 118. Dr. Neal writes that he had again examined the locality in company with Prof. L. C. Johnson, who reports that the deposit overlies the Vicksburg limestone of Eocene age. Dr. Neal adds that the deposit appears to be the portion of the border of a lagoon of post-Tertiary age, and that it is now about 100 feet by 50 feet in extent. He also remarks that he has anxiously looked for relics of man, but thus far in vain. The fossils are mingled together in the greatest confusion, are badly fractured, but not water-worn.

The remains submitted, besides several less characteristic fragments of a crocodile, a carnivorous animal about the size of a fox, and of a lama, consist of two well-preserved teeth of a Rhinoceros and a Hippotherium.

The tooth of the rhinoceros fortunately happens to be one of the most characteristic of the series, and presents differences sufficiently from those of the many extinct forms of this country to render it probable that it indicates another species. The specimen is the crown, but slightly worn, of a last upper molar of the left side. It is especially remarkable for the extent of production of the intermediate folds of the chief lobes of the crown, in comparison with their condition in known forms of the genus. The fold of the anterior lobe is directed backward about half the interval of the lobes, and extends from the base to the triturating border of the crown. Its upper portion is half cylindrical; its lower portion compressed from without inward, and half elliptical in the length. It has the shape of a knife with a

cylindrical handle and a wider half elliptical blade. The posterior fold, as long and wider than the former, curves forward and outward in advance of the free border of the anterior fold, coming into contact with the outer face of this below, but separated from it by an open crevice above. The meeting folds divide the interval of the lobes of the crown into an outer trilateral pit over two inches in depth, and an inner nearly rectangular recess about an inch and a half in depth. A well-produced basal ridge occupies the forepart of the crown; a feeble one, produced behind in a tubercle, the outer part of the crown; and a broad tubercle occupies the base of the interval of the lobes internally. The measurements of the specimen are as follows:—

Greatest transverse diameter at the anterior third,	56 mm.
Greatest fore and aft diameter externally, .	63 "
Greatest fore and aft diameter internally, .	55 "
Greatest depth at the antero-external border, .	63 "

The species may be distinguished by the name of RHINOCEROS PROTERUS. The subgenus, whether *Aceratherium*, *Aphelops*, or other, is of course only to be determined by the supply of other portions of the animal. The inferior molars and bones of a rhinoceros, indicated in the former communication on fossils from the same deposit, most probably also pertain to this species.

The extinct genus *Hippotherium*, a three-toed ancestor of our horses, was originally described from remains found in the Miocene and later Tertiary deposits of Europe. Remains of the same genus were first discovered in this country in the Ashley River phosphate beds of South Carolina, noticed in our Proceedings of 1853, p. 241, under the name of *Hipparion venustum*, and described in Holmes' post-Pliocene fossils, 1860, 105, pl. xvi, figs. 32, 33, as *Hippotherium venustum*. Since then a number of other species have been described by the speaker and Prof. Cope from remains found in various localities of this country. The tooth now under inspection is an upper molar, perhaps the fourth large one of the series. It indicates a small species, little more than half the size of the domestic horse, or of the *Hippotherium gracile* of Europe, and exhibits sufficient difference to assume that it indicates another species from those already described. The folding of the contiguous borders of the interior enamel islets of the worn triturating surface is less complex than in *H. venustum*, and the internal islet is elliptical instead of circular. The species may be named HIPPOTHERIUM INGENUUM. The measurements of the tooth are as follows:—

Hippotherium ingenuum.

Length at antero-internal corner of crown,	42 mm.
Breadth fore and aft of triturating surface,	19 "
Breadth transversely of triturating surface,	17 "

NEW GENERA AND SPECIES OF FOSSIL COCKROACHES, FROM THE OLDER AMERICAN ROCKS.

BY SAMUEL H. SCUDDER.

Since the publication of my essay on Palæozoic cockroaches,[1] a considerable number of new types of Palæoblattariæ have come to hand, largely through the endeavors of Mr. R. D. Lacoe, to whose favor I owe the opportunity of studying them, and partly from my exploration of an interesting locality in South Park, Colorado. Some of the former have since been published in a revision of the species of *Mylacris*,[2] and the more interesting of such as remain are described in this paper.

The two new genera of Mylacridæ are closely allied to, but differ considerably from, the known genera. Of the Blattinariæ, the species of *Oryctoblattina* is the first secured from America, and the Triassic genera and species are interesting, not only from the deposit in which they occur, but also from their relation to Carboniferous and Liassic types.[3] They will all be figured on another occasion.

PROMYLACRIS (πρό, μυλακρίς), nov. gen.

The mediastinal vein, though large and abundantly supplied with veins, terminates not far beyond the middle of the wing; most of the branches fork more than once; the scapular vein runs in a nearly straight course, and terminates a short distance beyond the mediastinal, playing a very insignificant part; the externomedian vein is far more important, crowding back the scapular vein on the one side and the externomedian on the other; the anal furrow is very deeply impressed and the anal area strongly convex, its veins regular, frequent and strongly curved.

Promylacris ovale, nov. sp.

Represented by a single specimen and its reverse in a nodule preserving well the anterior half of the body. The pronotum is regularly arched, about one-fourth as high as broad, and twice as

[1] Mem. Bost. Soc. Nat. Hist., iii, 23, *et seq.*

[2] *Ibid.*, iii, 299, *et seq.*

[3] Amer. Jour. Sc. (3), xxviii, 199, *et seq.*

broad as long. The front wings have a strongly developed humeral lobe and a costal margin of considerable convexity. The mediastinal branches are clustered into three groups; the scapular vein is composed of only two branches, each of which forks with slight divarication; the externomedian vein has three principal branches, all of which originate far toward the base of the wing; the internomedian area is unusually small, apparently not reaching so far out as the scapular area. The fragment is 20 mm. long and the wing 12 mm. broad, but it was probably about 29 mm. long.

Carboniferous deposits of Mazon Creek, Ill. Received from Mr. Wm. Gurley.

PAROMYLACRIS (πάρος, μυλακρίς), nov. gen.

The mediastinal vein consists of at least seven or eight principal branches, several of them forking close to the base, the outermost extending far toward the tip of the wing, making this area unusually important; the scapular is also important, the main vein running through the middle of the wing in a straight course to the tip; the externomedian branches do not separate widely, and occupy on the margin of the wing only the lower half of the broad apex; the anal furrow is deeply impressed, and strikes the middle of the inner margin.

Paromylacris rotundum, nov. sp.

The single specimen shows the larger portion of the upper surface, and all the more important parts, visible from above. The whole body is strongly arched, and the central portion of the pronotal shield, which is twice as broad as long, is elevated about 4·5 mm. above the margins. The front wings are obovate, scarcely narrower at tip than at base, barely twice as long as broad; the humeral angle very prominent. The scapular vein has four or five straight superior branches; the externomedian vein runs parallel to the scapular, and has two dichotomizing branches. The length of the wing is 29·5 mm., and its width 15 mm.

Carboniferous deposits of Mazon Creek, Ill. Mr. R. D. Lacoe, No. 2026.

SPILOBLATTINA (σπῖλος, Blattina) nov. sp.

This genus is allied to *Etoblattina*, but differs from it and from all other genera of Blattinariæ in the divergence of the scap-

ular and externomedian veins beyond the middle of the wing, and then their rapid convergence beyond a more or less conspicuous elongated spot (whence the generic name) which fills the space so produced; a similar arrangement is seen even more conspicuously between the the externomedian and internomedian veins, where the spot is much larger and round. All the species are Triassic.

Spiloblattina Gardineri, nov. sp.

A number of specimens of this were found, some of them nearly perfect. The wing is long and slender, more than three times longer than broad, the tip roundly produced. The mediastinal vein terminates some way beyond the middle, approaching the margin very gradually; the scapular runs parallel to the costal margin, slightly more removed from it in the apical than in the distal half, and terminates a little before the tip of the wing; it has many branches, usually compound; the externomedian vein begins to branch usually in the middle of the wing, about opposite the stigma in the interspace between it and the scapular vein, and its branches fill the apex of the wing. To form the enlarged cell for the median stigma, the curve of the main externomedian vein is graceful and very gradual. The anal terminates far before the middle of the wing. Length of wing about 17·5 mm., width 5·5 mm. Named after my son who obtained the first and best specimen seen in our exploration of the beds.

Triassic beds near Fairplay, Colorado.

Spiloblattina triassica, nov. sp.

In this species the wing appears to be more slender than in the others, although the exact proportions cannot be given from the imperfection of the specimens; all the branches have a more longitudinal and less arcuate course, the externomedian and scapular veins scarcely part from each other to give place to the stigma, and the divergence of the former and the internomedian veins is also less conspicuous. The wing was probably about 18 mm. long, and 5 mm. broad.

Triassic beds near Fairplay, Colorado.

Spiloblattina guttata, nov. sp.

This species differs from the others in the stoutness of the wing, which is proportionally much shorter than any of the others; in keeping with this peculiarity is the greater width of

both the mediastinal and scapular areas, and the more rapid descent to the margin of the termination of at least the former. In other respects the species completely resembles *S. Gardineri.* Two fragments only were obtained, which indicate a wing about 15 mm. long, and 7 mm. broad.

Triassic beds near Fairplay, Colorado.

Spiloblattina marginata, nov. sp.

This species, of which only a single specimen was found, is remarkable for the paucity of its neuration, and for the fact that all the veins and branches are margined with a slender dark edging. The scapular vein recedes more than usually from the costal margin opposite the very slight median stigma, and the externomedian vein is consequently more than usually curved to make place for it. The probable length of the wing was 18 mm. The inner margin being lost, the width can hardly be more than conjectured, but it was perhaps 7 mm.

Triassic beds near Fairplay, Colorado.

Oryctoblattina occidua, nov. sp.

The veins appear to originate from the middle of the upper half of the base of the wing, and have scarcely the least basal arcuation. The mediastinal vein runs at but slight distance from, and nearly parallel to, the costal border, in the outer half constantly but gradually approaching it, emitting numerous oblique, generally simple branches; the vein terminates in the middle of the outer half of the wing, and shows no such peculiarities at its tip as characterize *O. reticulata* of Europe. The scapular vein is also not so peculiar as there; it runs in near proximity and parallel to the mediastinal vein, but there is the same slight bend in its course at the base of the principal branch; the mass of the branches, which are fewer than in *O. reticulata*, do not arise as there from a vein emitted abruptly from near the base of the second branch, to which they are inferior, but from the principal branch itself, to which they are superior. The internomedian vein terminates at about the end of the middle third of the wing, and has only a few branches. The externomedian branches all terminate on the inner margin. The length of the wing is 19 mm., its breadth 7 mm.

Carboniferous beds of Mazon Creek, Illinois; R. D. Lacoe, No. 2039.

[illegible]

[illegible]

POROBLATTINA [illegible]

[illegible] species of that genus [illegible] from them principally [illegible] mediastinal area and the [illegible] area. The mediastinal [illegible] the anal, terminating far before [illegible] has consequently but a few offshoots; [illegible] sweeping downward, away from the costal [illegible] of the mediastinal, occupies nearly half

of the wing before curving upward again to terminate above the apex. The externomedian vein is arcuate and terminates on the lower margin not far from the tip, and has only three or four superior longitudinal branches. The anal furrow is strongly arcuate. The anal veins are nearly parallel to the inner margin, but impinge upon it near the anal furrow.

Poroblattina arcuata, nov. sp.

The costal border is considerably convex. The scapular vein is unusually arcuate and has a large number of mostly simple oblique branches. The externomedian and internomedian veins, on the contrary, have few and distant branches, and the former is also strongly arcuate. The whole surface of the wing is broken by closely crowded cross-veins, which are more transverse to the whole wing than to the interspaces. A single, rather imperfect specimen is known, indicating a species with a wing about 10 mm. long; the width is 4 mm., and apparently the wing was well rounded and much shorter in proportion to its breadth than in the next species.

Triassic beds near Fairplay, Colorado.

Poroblattina Lakesii, nov. sp.

The costal border is nearly straight and the wing elongate. The scapular vein is much less arcuate than in the preceding species and has a comparatively small number of distant, singly or doubly forked, oblique branches. The much less oblique branches of the internomedian vein are more frequent but appear less crowded from their simplicity, while those of the externomedian are more distant than the latter, and equally simple. There is no sign of any cross-venation. This species, like the preceding, is small, the wing measuring about 12 mm. long, and 4·5 mm. broad. Named after Prof. Arthur Lakes of the School of Mines at Golden, Colorado, the first discoverer of these fossils.

Triassic beds near Fairplay, Colorado.

A REVISION OF THE NORTH AMERICAN MELICÆ.

BY F. LAMSON SCRIBNER.

The determination of our North American species of the genus *Melica*, and the notes relative to their distribution, etc., contained in the present paper, are based upon the collections in the herbarium at Cambridge, the Torrey herbarium, and the herbarium of the Department of Agriculture at Washington, all of which have been kindly loaned me for this purpose, by those having them in charge. I have also consulted the herbarium of the Academy of Natural Sciences of Philadelphia, as well as several valuable private collections.

The following is a synopsis or analytical key of the species, as they appear to me, by which it is hoped they may be readily identified without the aid of more extended descriptions.

§ 1. GLYCERIÆ.

Spikelets 1–5 flowered, flowering glumes herbaceo-coriaceous, with a narrow scarious margin above, strongly 7-nerved.

Culms not bulbiferous, panicle many-flowered, spikelets 1½–2½ lin. long, with 1, or sometimes 2 perfect flowers.

Empty glumes shorter than the spikelet, rudimentary floret large, and nearly sessile. *M. imperfecta*. 1.

Empty glumes as long as the floret, the second one exceeding it, rudimentary floret small, long stipitate. *M. Torreyana*. 2.

Culms bulbiferous, panicle simple, few-flowered with short divergent branches, spikelets 4–7 lin. long, with 3–5 perfect florets, flowering glumes 2–3 lin. long, joints of the thickened rhachilla about 1 lin. long. *M. fugax*. 3.

§ 2. EUMELICA.

Spikelets 4–8 lin. long, with 2–8 perfect florets, flowering glume apparently many-nerved below (at least when dry), with a broad scarious margin above.

Culms not bulbiferous.

Empty glumes very unequal and decidedly shorter than the 3–5 flowered spikelets.

Panicle diffusely branched, many-flowered, the flexuose pedicels smooth or slightly pubescent. *M. diffusa*. 4.

Panicle narrow, the slender branches erect, or the lower slightly divergent, pedicels flexuose or recurved, densely pubescent. *M. Porteri.* 5.

Empty glumes unequal, the second nearly or quite as long (6–8 lin.) as the 4–6-flowered spikelets.

Panicle with 6–15 large, pendulous spikelets forming a simple secund raceme. *M. stricta.* 6.

Panicle strict, densely many-flowered above, interrupted below, branches and short, straight pedicels erect. *M. frutescens.*[1] 7.

Empty glumes subequal, nearly as long (4–5 lin.) as the 2-flowered spikelets.

Panicle few-flowered, sparingly branched below, often reduced to a simple raceme. *M. mutica.* 8.

Culms bulbous at base (excepting in occasional samples of No. 10).

The second glume decidedly shorter than the third.

Panicle nodding, loosely few-flowered, the slender branches erect spreading, flowering glume very broadly acuminate, obtuse or notched at the tip, terminal floret acute. *M. spectabile.* 9.

The second glume as long as the third.

Panicle erect, densely many-flowered, branched below, spicate above, spikelets about 4 lin. long, with about 3 perfect florets the rudimentary one obtuse. *M. Californica.* 10.

Panicle erect, branches appressed, few-flowered, spikelets 5–6 lin. long, with 5–8 perfect flowers, terminal floret acute. *M. bulbosa.* 11.

§ 3. BROMELICA.

Spikelets of 3–8 perfect florets, the lower exceeding the empty glumes; lower palet prominently 7-nerved, apiculate or distinctly awned by the excurrent midnerve at the notched or bifid or narrowly truncate or rarely long attenuated tip (Thurber).

Culms bulbiferous, panicle with spreading, very unequal few-flowered rays, the upper rays and spikelets mostly solitary.

Flowering glumes smooth or minutely scabrous, notched at the acute tip, the midnerve ending as a short point or awn between the teeth. *M. bromoides.* 12.

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[1] *Melica frutescens* approaches, by intermediate forms, very closely to *M. Californica*, but the membraneous character of its glumes, the unusual length of the outer ones, and the comparatively short palea (this being scarcely half as long as its glume) suggest a nearer relationship with *M. stricta.*

Flowering glumes ciliate on the margin and hirsute, especially below, with scattered hairs, long attenuated into a narrow subulate point, but not awned. *M. subulata*. 13.

Culms not bulbous at the base, panicle contracted.

Flowering glume about 4 lin. long, ciliate on the margin below with long shining hairs, apex truncate or obtusely lobed, awn when present not exceeding 3 lin. in length. *M. Harfordii*. 14.

Flowering glume 5–6 lin. long, strongly scabrous, with a few stiff marginal hairs near the base, awn 4–7 lin. long. *M. aristata*. 15.

1. **Melica imperfecta**, Trin. in Mem. Acad. St. Petersb., 1840, 59, and Icon. Gram., t. 355; Bolander, Proc. Calif. Acad., 1870, iv, 101; Thurber in S. Wats. Bot. Calif., ii, 303. *M. colpodioides*, Nees. in Tayl. Mag. Nat. Hist., 1, 282; *M. panicoides* and *M. poæoides*, Nutt. in Pl. Gambl., 188.

HAB.—*California:* Hills, San Bernardino Valley, Parish Bros., No. 885, April, 1881; San. Bernardino Co., Parry and Lemmon, No. 403, 1876; G. R. Vasey, No. 664, 1880; Southern California, Parry and Lemmon, No. 404; Santa Maria, Sta. Barbara Co., Lorenzo Jared, 1881; Santa Barbara, Mrs. E. Cooper, 1879; "Abundant in dry rock places," Mrs. R. F. Bingham, 1882; Fall Brook, M. E. Jones, No. 3092, March, 1882 (spikelets 2¼ lin. long); Guadaloupe Island, off Lower Calif., E. Palmer, No. 98, 1875; Los Angelos, Bolander, Kellogg & Co. (a form with unusually broad and obtuse outer glumes). Two-flowered forms, the *M. poæoides* of Nuttall, come from San Francisco, Bolander, No. 6076, in part; Hills, San Diego, C. G. Pringle, 1882; Miss Scott, 1880; Dr. Cleveland, 1882.

Var. **refracta**, Thurber in S. Wats. Bot. Calif., ii, 303.

HAB.—Near San Bernardino, Calif. J. G. Lemmon, No. 1471, 1879.

Var. **flexuosa**, Bolander, Proc. Calif. Acad., iv, 101; Thurber, l. c., 303.

On the road from Mariposa to Clarks, Bolander; Santa Inez Mission, Brewer, No. 569 (teste Thurber).

I do not recognize this variety among the specimens I have in hand.

Var. **minor**.

Characterized by its comparatively low and densely tufted habit, short and chiefly radical leaves, compressed or angular culms, slender few-flowered panicle, the short branches divergent or even reflexed; the spikelets are generally smaller than in the species and the outer glumes usually shorter and more obtuse.

HAB.—San Bernardino Mts., Parish Bro., No. 856, May, 1882.

2. **Melica Torreyana.** *M. imperfecta*, var. *sesquiflora*, Torrey in Herb.

The specimens thus ticketed by Dr. Torrey were collected in California, by Dr. Bigelow, in 1853–4.

This proposed new species is distinguished from *M. imperfecta*, with which it is very closely allied, by its more membraneous, longer and more acute glumes—the second one equaling or exceeding the floret—by the hairs on the back of the flowering glume above the middle and by the *long-pedicelled* rudimentary floret, characters which seem to me to be of specific value.

Bigelow's specimens are immature, but the typical form is well represented by the specimens distributed by Bolander, Kellogg & Co. (1872). In these specimens the culms are 3 ft. high or more, leaves numerous, flat, 2–3 lin. wide, 6–8 in. long; ligule 3–4 lin. long, lacerated; panicle 6–10 in. long, diffuse, the slender flexuose branches 2–4 in. long and few-flowered at the ends, naked below. The characters of the spikelets are well shown in fig. 3, Pl. I.

Forms with two-flowered spikelets occur, but the second floret and rudiment are long-pedicelled, while in similar two-flowered forms of *M. imperfecta*, these are both nearly sessile.

No. 13 Bolander. and No. 6076 Bolander in part belong to this species. No. 586, collected by Dr. Torrey at New Almaden, California, in 1865, is a narrow-panicled form of *M. Torreyana*, closely resembling *M. imperfecta*, but at once recognized by the characters above noted.

3. **Melica fugax,**[1] Bolander, Proc. Calif. Acad., iv, 104; Thurber in S. Wats. Bot. Calif., ii, 304. *M. Geyeri*, Thurber, Bot. Wilkes' Exped., 492, not Munro.

HAB.—*California*: J. G. Lemmon, 1875; Sierra Valley, J. G. L., 1873 and 1874; Donner Lake, Bolander, Kellogg & Co., 1872; Plumas Co., Mrs. Austin, 1877. *Oregon:* Dry mountain sides, Union Co., W. C. Cusick, No. 1032, June, 1882. *Washington Territory:* Open pine woods, Falcon Valley, W. N. Suksdorf, Nos. 61 and 16, 1883.

In the spikelets of *Melica fugax*, the rhachilla is smooth, thickened and of a peculiar spongy texture, quite unlike that of any other North American species.

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[1] The *Melica*, from Mt. Shasta, referred to in my List of Pringle's Grasses (see Torr. Bull., x, p. 31, No. 72), is not *M. fugax*, nor am I able to identify it with any of the known species, unless it be an unusual form of *M. bulbosa*, Geyer. The specimens in hand are too meagre for more definite conclusions.

4. **Melica diffusa**, Pursh Flor., i, 77; Kunth En. Pl. i, 377; Steudel Gram., 291: *M. altissima*, Walt, Flor. Carol., 78. *M. glabra*, Michx., i, 62 (in part). *M. mutica*, var. *diffusa*, Gray in Man., 626. *M. scabra*, Nutt., Fl. Ark., 148.

Var. **nitens**.—*M. nitens*, Nutt. in Herb. Phila. Acad. *M. mutica*, Torr. in Marcy's Rept.

Differs from the species in its more leafy culms, narrower leaves, more densely flowered panicle, and in its much broader and more unequal outer glumes, the second one being nearly as long as the spikelet.

DISTRIBUTION.—Pennsylvania, Illinois, southward and westward to Texas. The variety = No. 3464 *a*, Curtiss' Distribution N. Am. Plants, coll. in Texas by J. Reverchon; also 389, Lindheimer, and 2062, C. Wright. Nos. 729, Lindheimer (1847), and 769, C. Wright (1849), belong to the species.

5. **Melica Porteri**, Scribner in Rusby's Arizona plants, No. 881½, 1883, and in Pringle's distribution of 1884. *M. mutica*, var. *parviflora*, T. C. Porter in Porter & Coulter's Fl. of Colorado, 149; *M. stricta*, Brandegee, Fl. Southwestern Colorado, p. 244.

HAB.—*Colorado:* Glen Eyrie, near Colorado City, T. C. Porter, July, 1872, and August, 1873. "This Melica, which I have from several stations in Colorado, I am now inclined to think a good species, as you do." T. C. P. in litt., December, 1882; Chiann Cañon, M. E. Jones, No. 1550, June, 1879; Cañon of the Rio La Plata, and Parrott City (alt., 8500 ft.), T. S. Brandegee; Hall and Harbour, No. 228. *Arizona:* Rusby, 1883; Santa Rita Mts., Pringle, 1884; Sierra Blanca, J. T. Rothrock, No. 805, 1874; J. G. Lemmon, 1884 (specimens differing from the type in their smaller spikelets, scarcely exceeding 4 lin. in length, while in the ordinary forms they are two lines longer). *New Mexico:* C. Wright, No. 2063, 1851, and Fendler, No. 924, 1847; G. R. Vasey, No. 142, July, 1881. *Texas:* Chixos Mts., V. Havard, No. 19, 1883 (a small flowered form like that collected by Lemmon in Arizona).

6. **Melica stricta**, Bolander, Proc. Cal. Acad., iii, 1863, p. 4, and iv, p. 104; Watson, Bot. King's Exped., 384; Thurb. in S. Wats. Bot. Cal., ii, 303.

HAB.—*California:* Virginia City, Bolander, No. 47; Yosemite Valley. Bolander, No. 6089, 1866; Sierra Co., J. G. Lemmon, No. 223, 1874; Bolander, Kellogg & Co., 1872 (alt. 7000 ft.); Sierra Nevada, "crevices of high rocks, 9000 ft.," E. L. Greene, No. 417, Oct., 1884; same district, alt. 9500 ft., C. G. Pringle, Sept., 1882; Plumas Co., R. M. Austin, 1878; Soda Springs, alt. 9000 ft., M. E. Jones, July, 1881; "Dry ridges, among rocks," Bear Valley, San Bernardino Mts., Parish Bros., No. 1553, Aug., 1882. *Nevada:* East Humboldt Mts., alt. 8000 ft., Aug., and Pah Ute Mts., alt. 5500 ft., June, S. Watson, No. 1305, 1868.

Note.—The inflorescence of this alpine species is similar to that of *M. Porteri*, but the panicle is much shorter, with only about a dozen spikelets, rarely more than 20, and the spikelets themselves are very much larger.

7. **Melica frutescens.**

Culms 2½–3½ feet high, simple or branched near the base, leafy; leaves narrow, involute near the tip, scabrous, as are also the sheaths. Panicle 6–12 inches long, strict, densely flowered and spicate above, interrupted below, the appressed branches 1–3 inches long, densely flowered, or the longer ones naked below. Spikelets about 6 lin. long, with usually 5 perfect florets; first glume about 5 lin. long; the second a line longer, nearly equaling the spikelet; third glume about 4 lin. long, obtuse, the papery-membraneous tip occupying fully a third of its length. Palea usually about one-half the length of its glume.

HAB.—*California:* Southern California, Parry and Lemmon, No. 401, 1876; Mountains San Diego Co., C. G. Pringle, April 20, 1882; Lower California, near the United States border, C. R. Orcutt, No. 513, May, 1883; Near the Tia Juana, M. E. Jones, No. 3748, April 6, 1882.

8. **Melica mutica,** Walt., Flor. Carol., 78 (1788). *M. glabra,* Pursh.; Mx. (in part.), *M. mutica,* var. *glabra,* Gray in Man., 626. *M. speciosa,* Muhl., Ind. Fl. Lanc. (1791), 161, and Gram., i, 87. *M. racemosa,* Muhl. Gram., 88. *M. Muehlenbergiana,* Schult, Mant., 2, 294 (after Kunth).

DISTRIBUTION.—Pennsylvania, southward and westward to Texas, (781, E. Hall).

Distinguished from *M. diffusa*, with which it has been united by some authors, by its more slender habit, less branched and fewer flowered panicle, which is often reduced to a simple raceme. The spikelets also rarely have more than two perfect florets, the outer glumes are more nearly equal in length, and often quite as long as the spikelet, while the flowering glumes are broader and more obtuse.

9. **Melica spectabile.** *M. bulbosa,* S. Wats., Bot. King. Exp., 383; Porter & Coulter, Fl. Colorado, 149.

HAB.—*Montana:* Crow Creek Mts., etc., alt. 6000 ft., Scribner, No. 385, 1883; Bozeman Pass, Wm. M. Canby, No. 368, 1883. *Colorado:* Twin Lakes, Upper Arkansas, and Plains near Ogden, T. C. Porter, 1872. Yellowstone Park, C. C. Parry, No. 295, 1873. *Utah:* Cottonwood Cañon, alt. 10,000 ft., S. Watson, No. 1303, July, 1869. *Idaho:* Beaver Cañon, S. Watson, No. 455, July, 1880.

This grass has been referred to Geyer's *M. bulbosa* by authors, but aside from its affecting higher elevations, it is readily distinguished from that species by its usually taller and more slender culms, by its more open and nodding panicle, by the more

slender and flexuose pedicels, by its shorter empty glumes, and by its broader flowering glumes, which taper abruptly to a rounded and usually two-lobed summit.

10. **Melica Californica,** *M. poæoides*, Torrey, in Pac. R. Rep., iv, 157, non Nutt. *M. bulbosa*, Thurber, in S. Wats. Bot. Calif., ii, p. 304, non Geyer.

HAB.—*California:* Bolander, Nos. 32 and 6120; Kellogg & Harford, No. 1133, 1868–9; San Bernardino, Parish Bro., No. 865, 1881.—Mud Springs, Upper Yellowstone, T. C. Porter, 1871.

The bulbous character of the base of the culm, although usually manifest, is sometimes wholly wanting, as in Prof. Porter's specimens from the Upper Yellowstone.

Prof. Thurber's description in the Botany of California applies only to the Californian plant (*M. Californica*); from the distribution given, however, and the authors cited, it is evident that he supposed this to be identical with Geyer's plant, which is typically represented by Cusick's specimens, and also my *M. spectabile*. I have endeavored to point out the characters that distinguish these three species, which, to me, appear sufficiently well marked to leave little doubt of their specific rank.

11. **Melica bulbosa,** Geyer, in Hook. Jour. Bot., viii, 1856, 19 (without description); Gray, Proc. Am. Acad., viii, 409.

Culms bulbous at the base, growing singly or densely tufted, usually about 2 ft. high, simple; sheaths and upper surface of the leaves scabrous or (in Howell's specimens) retrosely pubescent; panicle slender erect, the short 1–3 flowered branches appressed; spikelets 5–7 lin. long with 6–8 perfect florets; empty glumes obtuse, the first about 3 lin. long, the second a line longer and nearly equaling the third or first flowering glume, which is oblong lanceolate, obtuse or notched at the tip and generally larger and firmer in texture than in *M. Californica.*

HAB.—*Oregon:* "Rocky ravine, Upper Platte, and only seen in one grassy spot," Geyer, No. 11; Union Co., W. C. Cusick, No. 900, 1880 and 900 *a*, 1882; Bolander, Kellogg & Co., 1872; Henderson, 1882; E. Hall, No. 635, 1871; Howell, 1881. *Washington Territory:* T. S. Brandegee, No. 1182, 1883. *Nevada:* Wheeler, 1872; West Humboldt Mts., alt. 8500 ft., S. Watson, No. 1304, 1867. *Idaho:* Bois City, Dr. J. E. Wilcox, 1883. *Utah:* Wasatch Mts., alt. 9000 ft., M. E. Jones, 1879; Ogden, J. M. Coulter, 1872. *Montana:* Belt Mts., alt. 6000 ft., Scribner, No. 386, 1883 (spikelets crowded above, 7–8 lin. long and 5–7 flowered).

12. **Melica bromoides**, Gray, Proc. Am. Acad., viii, 409; Thurber in S. Wat. Bot. Cal., ii, 304. *M. Geyeri*, Munro, ex Bolander, Proc. Cal. Acad., iv, 130. *M. poæoides* and *M. p.* var. *bromoides*, Nos. 6120, 40 and 6119 of Bolander's distributed sets. *Glyceria bulbosa*, Buckley, Proc. Phila. Acad., 1862, 95!

HAB.—*California:* Redwoods, Coast Range, Mt. Dana, Bolander, No. 6119; San Francisco, No. 6120; Woods, Ukiah, Mendocino Co., Bolander, No. 40. *Oregon:* Near Waldo, Thos. Howell.

Note.—Mr. Howell sends from Oregon (No. 335, 1884) a form that differs from the type in its more open and fewer-flowered panicle; the flowering glumes are also considerably longer, and entire, or but slightly notched at the tip, without any awn. This form has a decided festucoid "look," and may be designated as var. *Howellii.*

13. **Melica subulata.** *Bromus subulatus*, Griseb. in Ledeb. Fl. Ross., iv, 358; Gray, Proc. Am. Acad., viii, 410. *M. acuminata*, Bol., Proc. Cal. Acad., iv, 104; Thurber in S. Wats. Bot. Cal., ii, 305. *M. poæoides*, var. *acuminata*, of Bolander's distribution, No. 4698.

HAB.—*California:* Mendocino Co., Bolander, 1866. *Oregon:* E. Hall, No. 645, 1871; "Low mountains," Union Co., W. C. Cusick, No. 876, 1880; "Along mountain streams," Howell, 1880, distributed sub nom. "M. Geyeri"; Kellogg and Harford, No. 1112, 1868–9; Suavie's Island, Howell, 1883. *Washington Terr.:* Woods, Columbia River, W. N. Suksdorf, 1882; G. R. Vasey, No. 129, 1883.

Festuca subulata, Brong., is cited as a synonym for this species by Dr. Gray and Prof. Thurber. The description, in Led. Fl. Ross., of *F. subulata*, Brong., and the synonyms there quoted point to a very different grass. I would rather concur with the opinion expressed by Prof. E. Hackel, that *F. pauciflora*, Thurber, in S. Wats. Bot. Cal., ii, 318 (No. 6073, Bolander), is the *F. subulata*, of Brongard, and not Thunberg's *F. pauciflora.*

14. **Melica Harfordii**, Boland. in Proc. Calif. Acad., iv, 102; Thurber in S. Wats, Bot. Calif., ii, 305.

HAB.—*California:* Cañons, Santa Cruz Coast, Bolander, and Redwood on the Upper Mattole River, No. 6424: Sierra, alt. 4000 ft., Bolander, Kellogg & Co., 1872; G. R. Vasey, 1875 (these specimens show well the tufted habit of the species); J. G. Lemmon. *Oregon:* Waldo, Howell, June, 1884; L. F. Henderson, 1883. *Washington Territory:* Willamette Slough, Howell, May, 1882; Dry rocky hillsides, Columbia River, Klickitat Co., W. N. Suksdorf, 1882.

"This grass I collected in June, 1864, in a gulch near the summit of Santa Cruz Mts. It grows in large tufts 3–6 ft. high, the spikelets breaking asunder, even in what appear to be young specimens, at the slightest touch. Panicle contracted, erect,

slightly drooping at the apex, caused by the club-shaped heavy top, often 9 in. long, with a few or even a single branch far below the main panicle. This spring I noticed the same grass near Ukiah."—*Bolander in Herb. A. Gray.*

In Bolander's specimens the spikelets are about 5 lin long, and less than a line in width; the second empty glume is scarcely 3 lin. long, and the slender awn of the flowering glume is about a line in length. In the Oregon specimens the spikelets are 8 lin. long and nearly 2 lin. in width, with the second glume nearly 5 lin. long.

15. **Melica aristata,** Thurb in Bolander's Revision of the *Melicæ*, Proc. Calif. Acad., iv, 103, and in S. Wats. Bot. Calif., ii, p. 305.

HAB.—*California:* Yosemite Valley, Bolander, No. 4861, 1866 (sheaths and leaves densely pilose); Bolander, Kellogg & Co., 1872 (culms stout, 3 ft. high, panicle a foot long, purplish); Emigrant Gap, M. E. Jones, 1882; Mt. Shaster, alt. 6000 ft., C G Pringle, August, 1881 (culms slender, smooth, sheaths and leaves scabrous, panicle simple, few-flowered, dark purple). *Washington Territory:* W. N. Sukadorf, 1883 (panicle few-flowered, green.)

EXPLANATION OF PLATE I.

FIG. 1. Spikelet of *Melica imperfecta.*
" 2. Same with the outer glumes removed, showing the nearly sessile rudimentary floret, *r.*
" 3. Spikelet of *M. Torreyana.*
" 4. Same with outer glumes removed.
" 5. Spikelet of *M. fugax.*
" 6. Spikelet of *M. Californica.*
" 7. Spikelet of *M. bulbosa*, from the typical plant.
" 8. Anterior view of floret of same, showing palea.
" 9. Terminal empty glume and rudiment of same.
" 10. Spikelet of *M. bulbosa*, the florets raised above the empty glumes; unusually large, from the Idaho specimens.
" 11. Spikelet of *Melica spectabilis.*
" 12. Terminal empty glume and rudiment of same.
" 13. Anterior view of flowering glume of same, flattened to show veins, etc.
" 14. Seed of *M. bulbosa* from Howell's specimens.
" 15. Spikelet of *Melica frutescens.*
" 16. Floret of same.
" 17. Spikelet of *Melica Porteri.*
" 18. Dorsal view of flowering glume, flattened out above.
" 19. Spikelet of *Melica subulata.*
" 20. A floret from the spikelet of *Melica bromoides.*

All enlarged on the same scale, excepting fig. 14.

MARCH 17.

Mr. GEORGE W. TRYON, Jr., in the chair.

Twenty-four persons present.

The following papers were presented for publication:—

"Entomologia Hongkongensis.—Report on the Lepidoptera of Hongkong," by F. Warrington Eastlake.

"Description of a supposed new species of the genus Cyanocorax," by Alan F. Gentry.

The death of Titian R. Peale, a member, was announced.

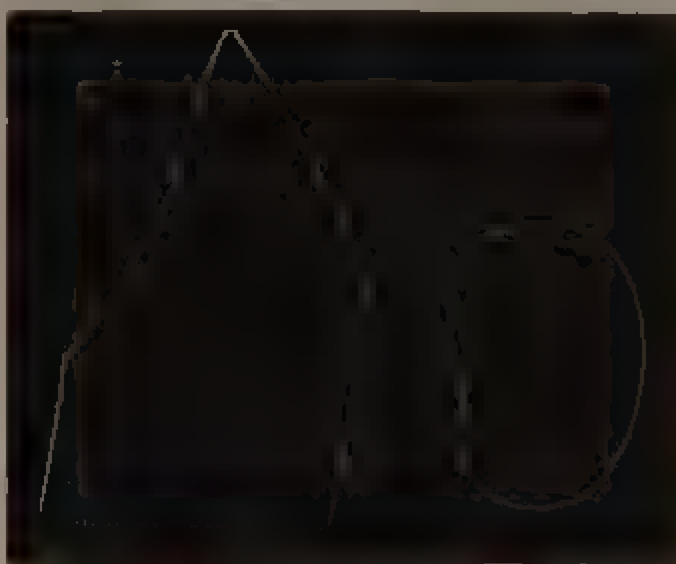
MARCH 24.

The President, Dr. LEIDY, in the chair.

Twenty-six persons present.

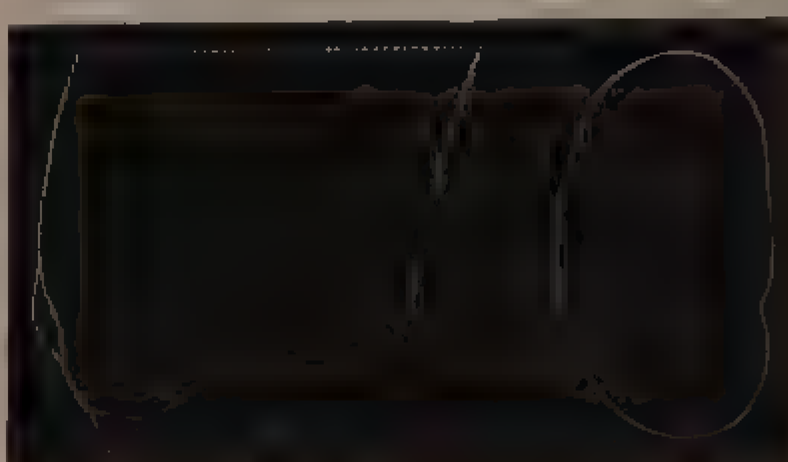
Remarks on Mylodon.—Prof. LEIDY remarked that among the fossils of *Mastodon*, *Equus*, etc., from the salt mines of New Iberia, La., noticed in the Proceedings of 1884, p. 22, there are three teeth, which are probably to be referred to the reputed *Mylodon Harlani*. Of this species we are sufficiently well acquainted with the posterior three lower molars, but know little of the first lower molar, and nothing of the upper teeth. One of the Louisiana specimens accords in form and size with the third lower molar, in the best preserved jaw-fragment (see Extinct Sloth Tribe, pl. xiv, 1, 2), from Big-bone-lick, Ken., regarded as characteristic of *Mylodon Harlani*. The other Louisiana specimens, in comparison with the complete dental series in both jaws of *Mylodon robustus*, as represented in the famous memoir of Prof. Owen, are so unlike any of the teeth of this animal, that they might readily be considered as pertaining to another genus. One of the specimens, of which the triturating extremity and a transverse section are represented in the outline figures 1, 2, he took to be a first lower molar. It has lost all its cementum, but is otherwise well preserved. It is worn off in deep slopes, of which the posterior is more than an inch long, and the anterior little less than an inch. The transverse section is reniform, widest in front, and agrees in shape and size with a fragment of the corresponding tooth (*op. cit.*, pl. xvi, 19 *a*) retained in the jaw-fragment from Kentucky. In all the teeth of *Mylodon robustus*, the triturating surface inclines comparatively little from a level. Such also is the case in all the teeth of the ramus of a lower jaw, from Natchez, Miss., attributed to a half-

grown animal of *Mylodon Harlani*, preserved in our museum. In this, among some rude casts in plaster, the originals of which



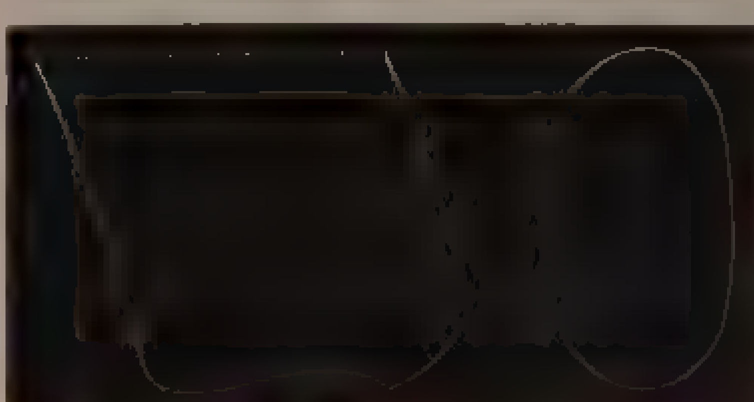
1 2

were described by Dr. Harlan, under the name of *Orycterotherium missouriense* (Am. Jour. Sci., 1843, 69), and subsequently referred to *Mylodon Harlani*, is one of a lower-jaw fragment, which contains the first molar, and the mutilated base of the second. The latter, in the perfect state, would appear to accord in shape and size with the corresponding tooth in the Kentucky jaw-fragment, referred to *Mylodon Harlani*. The first molar is unlike that of *Mylodon robustus*, but sufficiently accords in size,



3. 4.

shape, and condition of wear, with the Louisiana tooth to regard this as pertaining to the same animal. The remaining Louisiana specimen is not only unlike any of the teeth of *Mylodon robustus*, but differs from them to such a degree as to render it doubtful whether it belongs to the same genus. In comparison with other teeth of the lower or upper



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series, in size and shape, it accords with the canine molars of *Megalonyx* more than it does with any of the teeth of *Mylodon*. The triturating extremity and transverse section are represented in the outlines 3 and 4. It is more uniformly elliptical in transverse section than in the canine molars of *Megalonyx*, and is devoid of the abrupt median bulge

inwardly of the latter. Regarding it as a first upper molar, it is twice the breadth of the corresponding tooth of *Mylodon robustus*, not only absolutely, but also proportionately in comparison with all the other teeth, except the last one of the lower series. The triturating extremity is worn away obliquely and concavely behind for about two-thirds the breadth of the tooth, and obliquely in front the remaining third of the breadth, but the slopes extend only half the depth observed in the accompanying specimen of the first lower molar. In view of the dentition of *Mylodon robustus*, it seems improbable that this tooth should belong to an animal of the same genus, nor would it appear to be adapted as an opponent to the comparatively narrow, long-pointed tooth which accompanies it. Nevertheless, he was suspicious that both these teeth may pertain to the *Mylodon Harlani*, partly from the fact that the lower-jaw fragment, originally referred to *Orycterotherium missouriense*, and then to the latter, contains a first molar like the Louisiana specimen, and partly from the fact that the jaw-fragment was accompanied by an isolated molar tooth nearly resembling the supposed upper first molar from Louisiana. A plaster cast of the tooth referred to *Orycterotherium*, of which the triturating extremity and transverse section are represented in the outlines 5 and 6, though rather smaller, is sufficiently like the corresponding Louisiana tooth to render it probable this belonged to the same animal. Admitting that the two Louisiana specimens may not belong to the reputed *Mylodon Harlani*, he felt that the coincidence of facts is such as not to justify a conclusion to refer them to a new genus, and if further discovery should demonstrate that they really pertain to this animal, it becomes a question whether the difference of the teeth from those of *Mylodon robustus* is not sufficient to restore the name of *Orycterotherium missouriense*.

Fig. 1. Outer view of the first lower molar; Louisiana specimen; length, 85 mm. Fig. 2. Transverse section; the front above, the outer side to the right; fore and aft, 24 mm.; short diameter, 17 mm. Fig. 3. Outer view of the first upper molar, Louisiana specimen; length, 83 mm. Fig. 4. Transverse section; fore and aft, 34 mm.; short diameter, 19 mm. Fig. 5. Outer view of cast referred to *Orycterotherium;* length, 67 mm. Fig. 6. Transverse section; fore and aft, 29 mm.; short diameter, 17 mm.

The following were ordered to be printed:—

A REVIEW OF THE AMERICAN GENERA AND SPECIES OF BATRACHIDÆ.

BY SETH E. MEEK AND EDWARD A. HALL.

In the present paper we have attempted to collect the synonymy of all the genera and species of Batrachidæ known from American waters.

The specimens examined by us all belong to the Museum of the Indiana University.

Analysis of Genera of Batrachidæ.

a. Dorsal spines two; opercle very small, its posterior part developed as a single strong spine; subopercle feebly developed, narrowed and not ending in a spine; body scaleless.

b. Spines of dorsal fin and operculum hollow and connected with venom glands; lateral line on sides of body single; no canine teeth. THALASSOPHRYNE. 1.

bb. Spines solid, without venom glands; several lateral lines on sides of head and body, composed of pores and shining spots, some of these accompanied by cirri; canine teeth present; vertebræ 12 + 31; frontal region depressed, forming a triangular area below level of temporal region, its median ridge very low. PORICHTHYS. 2.

aa. Dorsal spines three; opercle developed as two strong diverging spines; subopercle rather strong, with two spines similar to those of opercle.

c. Body scaleless; branches of subopercular spine parallel, the lower branch much the shorter; vertebræ 10 + 22; frontal region not depressed, its median ridge prominent. BATRACHUS. 3.

cc. Body scaly; branches of subopercular spine subequal and diverging; frontal region broad, flat and slightly depressed, its median ridge rather prominent. BATRACHOIDES. 4.

1. THALASSOPHRYNE.

Thalassophryne Günther, Cat. Fish. Brit. Mus., iii, 1861, 174 (*maculosa*).

In this genus only five species are recognized. These have been well described by Dr. Günther and Dr. Steindachner. They are noted for the development of poison glands in connection with their spinous armature.

Analysis of Species of Thalassophryne.

Common Characters.—Dorsal spines two; opercle very small, its posterior part developed as a single strong spine; subopercle feebly developed, narrowed and not ending in a spine; no scales on body. Spines hollow and connected with venom glands. Lateral line on sides of body single; no canine teeth. America.

a. Dorsal and anal fins joined to the caudal; teeth on premaxillaries smaller than on lower jaw; eye very small; lower jaw the longer. D. II–20; A. 18 or 19.

b. Anterior teeth on jaws in two rows.

c. Pectoral fins short, their tips reaching just to front of anal; head as wide as long; opercular spine about $\frac{1}{4}$ length of head; caudal $\frac{1}{2}$ length of head. Color chocolate-brown; no distinct dark bands on head; body, except belly and under side of head covered with numerous small, dark, round spots; anal clear brownish gray, edged with dark brown; no dark bands on sides of body. (*Steindachner.*) *Punctata.* 1.

cc. Pectoral fins longer, reaching past third or fourth anal ray; head $1\frac{1}{3}$ times as long as wide; opercular spine about $\frac{1}{3}$ length of head; caudal $\frac{2}{3}$ of length of head; mouth very oblique. Color brownish, marbled with darker; two distinct bands on head; dorsal and anal with brown spots arranged in distinct rows; six dark bands on sides of body, the first at spinous dorsal, the others along the base of soft dorsal. (*Steindachner.*) *Amazonica.* 2.

bb. Anterior teeth on lower jaw forming a band; mouth moderately oblique; head less than 3 in length of body; interorbital width $5\frac{1}{3}$ to $5\frac{1}{2}$ in length of head. Color more or less clear reddish brown; belly brownish yellow; base of fins reddish brown or whitish, the upper part of the fins deep dark brown, the two colors separated by a distinctly marked whitish streak. (*Steindachner.*) *Nattereri.* 3.

aa. Dorsal and anal fins not joined to the caudal.

d. Dorsal and anal fins rather short (D. II–19; A, 18); pectoral fins short, their tips reaching to origin of anal. Color brown, marbled with darker; pectoral fins and sides of body with some round black spots; chin and ventrals brownish; belly white. (*Günther.*) *Maculosa.* 4.

dd. Dorsal and anal fins longer (D. II–24; A, 24); pectoral fins longer, their tips reaching to sixth anal ray. Color of head, body, and fins brown, with a network of yellowish lines; dorsal, anal, caudal and pectoral fins with white margins. (*Günther.*) *Reticulata.* 5.

1. Thalassophryne punctata.

Thalassophryne punctata Steindachner, Ichthyol. Beiträge, v, 1876, 121 (Bahia; Porto Segro.)

Habitat.—Coast of Brazil.

This species is known to us only from Steindachner's description.

2. Thalassophryne amazonica.

Thalassophryne amazonica Steindachner, Ichthyol. Beiträge, v, 1876, 118 (Amazon River).

Habitat.—South America, Amazon Basin, in fresh water.

This species is known to us only from the description of Steindachner.

3. Thalassophryne nattereri.

Thalassophryne nattereri Steindachner, Ichthyol. Beiträge, v, 1876, 115 (Para).

Habitat.—Amazon Basin; Para.

This species is known to us only from the description of Steindachner.

4. Thalassophryne maculosa.

? ? *Batrachus gronovii* Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 482 (America).

? ? *Callionymus niqui* Gronow, Cat. Fish., Ed. Gray, 1854, 45.

Thalassophryne maculosa Günther, Cat. Fish. Brit. Mus., 1861, 175 (Puerto Cabello); Günther, Fishes of Central America, 1869, 436, pl. 68, fig. 1 (Puerto Cabello).

Habitat.—Eastern Coast of Central America; Puerto Cabello.

This species is known to us only from the description of Dr. Gunther.

Batrachus gronovii of Cuvier & Valenciennes = *Callionymus niqui* Gronow, perhaps, belongs to some species of this genus; but of this there can be no certainty, the descriptions are too imperfect.

5. **Thalassophryne reticulata.**

Thalassophryne reticulata Günther, Proc. Zoöl. Soc. London, 1864, 150 155 (Panama); Günther, Fish. Central America, 1869, 437, pl. 68, fig. 2 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 626 (Panama).

Habitat.—Western Coast of Central America; Panama.

This species is known to us only from the accounts of Dr. Günther and Professors Jordan and Gilbert.

2. PORICHTHYS.

Porichthys Girard, Proc. Acad. Nat. Sci. Phila., 1854, 141 (*notatus* = *margaritatus*).

This genus is remarkable for the development of its mucous pores, or "lateral lines." The number of vertebræ in *Porichthys* is much greater than in *Batrachus*, and the skull is somewhat different.

Analysis of Species of Porichthys.

Common Characters.—Dorsal spines two; opercle very small, its posterior part developed as a strong, single spine; suboperculum feebly developed, narrowed and not ending in a spine; no scales on body; spines solid, without venom glands; several lateral lines on sides of head and body, composed of pores and shining spots, some of these accompanied by cirri; canine teeth present; vertebræ 12 + 31; frontal region depressed, forming a triangular area below level of temporal region, its median ridge very low. Branchiostegals 6; interorbital area short, wide, and with shallow grooves. Air bladder more or less deeply divided into lateral parts. Pyloric appendages none.

a. Abdomen with two longitudinal series of pores, none of them accompanied by shining bodies; vomer with one canine tooth on each side. Color above brown, sides and belly silvery; dorsal fin with four oblique dark bands; posterior half of the caudal blackish, or with blackish spots; anal with two blackish spots posteriorly. Head 4⅔ in total length. D. II–34; A. 33. *Porosus.* 6.

aa. Abdomen with four longitudinal series of pores; each of which is accompanied by a shining silvery body; four rows of pores on sides of body. Color dark brownish above, below with brassy reflections; dorsal and anal with dark margins, a dark blotch below eye. Head 3¾ in length. D. II–37; A. 33.

b. Teeth on palatines numerous, subequal, none of them much enlarged; two canine teeth on each side on vomer, the inner ones usually about ½ length of outer ones. *Margaritatus.* 7.

bb. Teeth on palatines unequal, few; one to three on each side enlarged and canine-like; one canine tooth on each side on vomer. *Porosissimus.* 8.

6. Porichthys porosus.

Batrachus porosus Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 506 (Valparaiso); Gay, "Hist. Chili Zool., ii, 1844–54, 296 (Chili)."

Porichthys porosus Günther, Cat. Fish. Brit. Mus., iii, 1861, 177 (Chili); Jordan, Proc. U. S. Nat. Mus., 1884, 41.

Habitat.—Western Coast of South America, Chili.

We have not seen this species; we only know it from the accounts above cited.

7. Porichthys margaritatus. Midshipman; Singing-fish; Cabezon; Sapo.

Batrachus margaritatus Richardson, "Voyage Sulphur, Fishes, 1844–45, 67 (Pacific Coast of Central America)."

Porichthys margaritatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 368 (Cape San Lucas; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 626 (Central America; no description); Jordan & Gilbert, Syn. Fish. N. A., 1883, 958; Jordan, Proc. Acad. Nat. Sci., 1883, 291 (Panama; Vancouver's Island); Jordan, Proc. U. S. Nat. Mus., 1884, 41.

Porichthys notatus Girard, Proc. Acad. Nat. Sci., 1854, 141; Girard, U. S. Pacific R. R. Survey, 1859, 134 (San Francisco); Goode, Bull. U. S. Nat. Mus., 1879, 32 (Pacific Coast).

Porichthys porosissimus Günther, Cat. Fish. Brit. Mus., iii, 1861, 176 (in part; Vancouver Island); Gill, Proc. Acad. Nat. Sci. Phil., 1862, 280 (California); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 25 (San Diego; no description); Bean, Proc. U. S. Nat. Mus., 1880, 83 (West Coast; San Diego; Santa Barbara; Monterey; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 454 (Puget Sound; San Francisco; Monterey Bay; San Luis Obispo; Santa Barbara; San Pedro; San Diego; no description); Rosa Smith, Ichth. San Diego, 1880 (San Diego); Jordan & Jouy, Proc. U. S. Nat. Mus., 1881, 5 (Santa Barbara; Monterey; San Francisco; Puget Sound; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 65 (West Coast U. S.; no description); Bean, Proc. U. S. Nat. Mus., 1881, 263 (Puget Sound); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 274 (Gulf of California; no description); Jordan & Gilbert, Syn. Fish. N. A., 1883, 751; (not *Batrachus porosissimus* Cuvier & Valenciennes).

Habitat.—Western Coast of North America, from British Columbia to Panama.

This species has been confounded with *porosissimus*, but the absence of canine teeth on palatines (a constant character in all known specimens), warrants its separation. Professor Jordan has also examined the specimens in the British Museum. Those in that collection from the Atlantic have canine teeth on the palatines, the character assigned to *P. plectrodon*, while these are wanting in the examples from the Pacific.

A letter from Dr. H. E. Sauvage to Professor Jordan, states that the type of *Batrachus porosissimus* Cuv. and Val. "has a strong canine tooth on each side of the vomer; on the palatines are seen at first a strong, then some small teeth, and finally a strong curved tooth."

The application of the name *porosissimus* to the present form is thus shown to be improper.

8. **Porichthys porosissimus.**

Batrachus porosissimus Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 501 (Surinam; Cayenne; Rio Janeiro; St. Catherine); Jenyns, "Zool. Beagle, 1842, 99."

Porichthys porosissimus Günther, Cat. Fish. Brit. Mus., iii, 1861, 176 (Brazil); Jordan, Proc. U. S. Nat. Mus., 1881, 41; Jordan & Gilbert, Syn. Fish. N. A., 1882, 751; Jordan, Proc. Acad. Nat. Sci. Phil., 1883 (South America).

Porichthys plectrodon Jordan, Proc. U. S. Nat. Mus., 1882, 291 (Galveston); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 236 (Gulf of Mexico; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 307 (Gulf of Mexico; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 616 (Charleston; no description); Jordan & Gilbert, Syn. Fish. N. A., 1883, 958; Bean, Cat. Fish. Exhibited, London Exhibit, 1883, 47.

Habitat.—Atlantic Coast of North and South America, from Charleston to Rio Janeiro.

We have nothing to add to the very detailed description of this species, given by Jordan and Gilbert under the name of *Porichthys plectrodon.* The single specimen examined by us is from Pensacola.

3. BATRACHUS.

Batrachus Bloch & Schneider, Systema Ichthyol., 1801, 42 (*didactylus*, *tau*, etc.).

In this genus we recognize one American species, with two varieties; all found in the Atlantic.

Analysis of Species of Batrachus.

Common Characters.—Dorsal spines three; opercle developed as two strong, diverging, subequal spines; subopercle rather well developed; branches of subopercular spine parallel, the lower branch much the shorter. No scales on body. Vertebra $10 + 22$; frontal region not depressed, its median ridge prominent. Interorbital long and narrow with a deep groove. Branchiostegals 6. Teeth conical and blunt; lateral teeth on jaws and palatines in single rows. A large foramen in axil of pectoral fin (in North American species). Head about $2\frac{3}{5}$ in length of body; width of head from 3 to 4 in length of body. D. III–24 to 28; A. 19 to 22.

a. Two indistinct rows of pores on sides of body.

b. A fleshy tentacle between nostrils; color brownish or dusky greenish, mottled with darker and lighter, the dark on sides of body in large irregular blotches extending from base of dorsal to about $\frac{2}{3}$ distance to base of anal, and more or less covered with small pale spots; belly and chin plain white or yellowish. In specimens from shallow water or algæ, the brown becomes nearly black and more extended, the belly and chin spotted with darker, and top of the head has no distinct markings; in specimens from deeper water or from coral sand, the coloration is more brownish or yellowish. Soft dorsal with six to nine oblique light bands; anal with five to nine. Caudal and pectoral fins with five to seven light cross-bands, these formed chiefly from light spots; ventrals with some dark markings. *Tau.* 9.

bb. No fleshy tentacle between nostrils; color whitish or gray, everywhere blotched or spotted with brownish yellow and black, the black spots on top of head smaller and more numerous than on rest of body; a large black blotch at base of spinous dorsal, running up on fin; three black blotches along base of soft dorsal, which do not extend half the distance to base of anal. Pectoral with black spots which do not form cross-bands. Ventrals with more dark markings than in *tau.* Dorsal, anal and caudal marked nearly as in *tau.* *Tau pardus.* 9 *b.*

aa. Two very prominent rows of pores on sides of body; teeth more numerous than in *Batrachus tau.* Cirri above eyes very large (Cuv. and Val.). *Tau cryptocentrus.* 9 *c.*

9 a. **Batrachus tau.** Toad-fish; Sapo.

Gadus tau Linnæus, Systema Naturæ, ed. xii, 1766, 439 (Carolina); Schoepf, Beobacht. viii, 1788, 141 (New York); Walbaum, Genera Pisc., 1792, 185 (Eastern America).

Batrachus tau Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 478 (New York); De Kay, New York Fauna, Fish, 1842, 168, pl. 28, f. 26 (New York); Storer, Syn. Fish. N. A., 1846, 132; Günther, Cat. Fish. Brit. Mus., iii, 1861, 167 (New York; New Orleans); Gill, Cat. Fish. East Coast N. A., 1861 (name only); Poey, Syn. Pisc. Cuba, 1868, 390 (Cuba); Gill, Report U. S. Fish Comm., 1871–72, 798 (New Jersey; Florida; Cuba; no description); Baird, Report U. S. Fish Comm., 1871–72, 824 (Wood's Holl); Poey, Enumeratio Pisc. Cubensium, 1875, 136 (Cuba); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 372 (Beaufort, N. C.; no description); Goode, Proc. U. S. Nat. Mus., 1879, 110 (Mouth of the St. John's River, Fla.; no description); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 127 (Pensacola); Goode & Bean, Proc. U. S. Nat. Mus., 1879, 334 (Pensacola; Beasley's Point, N. J.; Norfolk, Va.; Punta Russa, Fla.; Wood's Holl, Mass.; Indianola, Tex.); Goode, Bull. U. S. Nat. Mus., xiv, 1879, 32 (Wood's Holl; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 83 (Wood's Holl, Mass.; Noank, Conn.); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 291 (Pensacola, Fla.); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 616 (South Carolina; no description); Jordan & Gilbert, Syn. Fish. N. A., 1882, 750; Bean, Cat. Fish. Ex. U. S. Nat. Mus., 1883, 47; Jordan, Proc. U. S. Nat. Mus., 1884, 143 (Key West; no description).

Lophius bufo Mitchill, Trans. Lit. and Phil. Soc., New York, 1815, 463 (New York).

Batrachoides vernullas Le Sueur, "Mem. Mus., v, 1819, 157, pl. 17."

Batrachoides variegatus Le Sueur, Jour. Acad. Nat. Sci. Phila., iii, 1823, 399 and 401 (Egg Harbor, New Jersey).

Batrachus variegatus Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 484 (copied); Storer, Fish. Mass., 1839, 74 (Holmes' Hole); Storer, Syn. Fish. N. A., 1846, 133 (New York); Gill, Cat. Fish. East Coast N. A., 1861, 43 (Name only).

Batrachus celatus De Kay, New York Fauna, Fish, 1842, 170, pl. 50, f. 161 (New York); Storer, Syn. Fish. N. A., 1846, 133; Gill, Cat. Fish. East Coast N. A., 1861, 43 (Name only).

Habitat.—Atlantic Coast of North America, from Cape Cod to Cuba.

We have examined numerous specimens (from 3 to $9\frac{3}{4}$ inches in length) of this species from Key West, Florida. We find among these apparently the varieties *A* and *B* of Dr. Günther, and also intermediate grades.

In the young specimens the head is more narrow and rounded, and the lower branch of the subopercular spine proportionally larger than in the adult.

The deeper-water specimens are lighter in coloration than those from near the surface, and those from the coral reefs are paler than those from the green algæ and sea-wrack, otherwise no differences seem to exist.

9 b. **Batrachus tau pardus.**

Batrachus tau var. *pardus* Goode & Bean, Proc. U. S. Nat. Mus., 1879, 336 (Pensacola, Fla.); Jordan & Gilbert, Syn. Fish. N. A., 1882, 751.

Batrachus pardus Goode & Bean, Proc. U. S. Nat. Mus., 1882, 336 (Gulf of Mexico); Bean, Cat. Fish. London Exhibit., 1883, 47 (Pensacola, Fla.); Jordan, Proc. Acad. Nat. Sci. Phila., 1884, 45 (Egmont Key).

Habitat.—Gulf of Mexico; Egmont Key; Pensacola.

The coloration of *pardus* is very different from that of *tau*. In the specimen (13⅝ inches in length, from Pensacola) which we have examined, the fleshy tentacle between nostrils is wanting, while in all the specimens of *B. tau* this is present.

The former seems to be a deep-water variety or subspecies of the latter. The few specimens of *pardus* known are from considerable depths. The texture of the flesh and the skin is less firm than in *tau*.

9 c. **Batrachus tau cryptocentrus.**

Batrachus cryptocentrus Cuvier & Valenciennes, Hist. Nat. Poiss., 1837, 485 (Bahia).

Habitat.—Eastern Coast of South America (Bahia).

This form is known only from the meagre description of Cuvier and Valenciennes. We venture to place it among the varieties of *tau*, as no diagnostic character of importance appears in the description.

4. BATRACHOIDES.

Batrachoides Lacépède, Hist. Nat. Poiss., iii, 1798, 306 (*Batrachoides tau* Lacépède = *Batrachus surinamensis* Bloch).

This genus is closely allied to *Batrachus*, but it seems to be sufficiently distinguished by the scaly body. Two species are found in American waters.

Analysis of Species of Batrachoides.

Common Characters.—Dorsal spines three; opercle developed as two strong diverging spines; subopercle strongly developed; branches of subopercular spine subequal and diverging; body covered with small ctenoid scales; frontal region broad, flat, and slightly depressed, its median ridge rather prominent.

a. Teeth small, about 14 on vomer; anterior teeth on lower jaw in a band; lateral teeth on palatines enlarged and canine-like, irregularly arranged; pectoral without pores on its inner surface. Color grayish, darker on sides and head; base of soft dorsal pale, with a dark irregular line above; upper part of fin lighter; caudal nearly black; anal fin light, with some dark markings. Head $3\frac{1}{4}$ in length of body; depth 6. D. III–29; A. 26. *Surinamensis.* 10.

aa. Teeth larger, about 8 on vomer; anterior teeth on lower jaw in two rows; lateral teeth on lower jaw gradually increasing to middle of jaw, behind which they become abruptly smaller, and then gradually increase to end of jaw; three teeth on middle of palatines enlarged and canine-like, the middle one the smallest; pectoral with a row of pores on inner surface. Color olivaceous brown; some indistinct dark cross-bands on body; dorsal with about seven very irregular oblique dark bars, anal with about five; pectorals and caudal dark, with few light cross-bands. Head 3 in length of body. D. III–26; A. 22. *Pacifici.* 11.

10. **Batrachoides surinamensis.**

Batrachoides tau Lacépède, Hist. Nat. Poiss., iii, 1798, 306, pl. 12, fig. 1 (not *Gadus tau* L.)

Batrachus surinamensis Bloch & Schneider, Systema Ichthyol., 1801, 43, tab. 7 (Surinam); Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 1837, 488 (Surinam); Günther, Cat. Fish. Brit. Mus., iii, 1861, 174 (Demarara; British Guiana; West Coast Central America).

Habitat.—Atlantic Coast of Tropical America; a specimen recorded by Dr. Günther from the Pacific Coast.

The single specimen of this species examined by us is from Curuca. The record given by Dr. Günther of this species from the Pacific Coast needs verification. It was not found at Panama by Professor Gilbert.

11. Batrachoides pacifici.

Batrachus pacifici Günther, Cat. Fish. Brit. Mus., iii, 1861, 173 (Panama); Günther, Fishes Central Amer., 1869, 435 (Panama).

Batrachoides pacifici Gill, Proc. Acad. Nat. Sci. Phila., 1863, 170 (West Coast of Central America); Jordan & Gilbert, Bull. U. S. Fish. Com., 1882, 3 (Panama; no description); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 626 (Panama; no description).

Habitat.—West Coast of Tropical America; Panama.

The single specimen of this species examined by us is from Panama, at which place the species was found to be abundant by Professor Gilbert.

A REVIEW OF THE SPECIES OF THE GENUS PIMEPHALES.

BY WILLIS S. BLATCHLEY.

I have examined numerous specimens of *Pimephales* and *Hyborhynchus* from various parts of the United States, with a view to discrimination of the species.

The genus *Hyborhynchus* is evidently unworthy of retention, and the entire group is, in my opinion, composed of but two species, *Pimephales promelas* and *Pimephales notatus*.

I give the synonymy of each and an analytical key giving the principal characters by which they may be separated.

The specimens examined belong to the Museum of the Indiana University.

a. Body comparatively short and deep, the greatest depth about 4 times in length of body; head short, convex, almost as broad as long in the adult, its length 4 in body; mouth slightly oblique; lateral line of various lengths, sometimes wanting on twenty or more scales; sometimes complete (variety *confertus*); origin of dorsal midway between pupil and base of caudal; ventrals reaching to or beyond first ray of anal; head, dorsal and pectoral fins of breeding males jet black, the snout with a few moderate-sized tubercles; scales 8–47–6. *Promelas.* 1.

aa. Body elongate, rather slender, the greatest depth about 4¾ times in length of body; head comparatively long, its length 4½ in body, its surface much depressed above and descending abruptly in front of nostrils; mouth horizontal; lateral line complete; origin of dorsal midway between snout and base of caudal; ventrals not reaching vent; males in spring with 16 large nuptial tubercles, often accompanied by a small protuberance of skin, resembling a barbel, at angle of mouth; scales 6–44–4. *Notatus.* 2.

1. Pimephales promelas Raf.

Pimephales promelas Rafinesque, Ichth. Oh., 1820, 53 (Lexington, Ky.); Kirtland, Rept. Zool. Ohio, 1838, 194; Kirtland, Bost. Jour. Nat. Hist., iii, 1838, 475; Storer, Synopsis, 1846, 418; Agassiz, Amer. Jour. Sci. Arts, 1855, 220; Putnam, Bull. M. C. Z., 1863, 8; Günther, Cat. Fish. Brit. Mus., vii, 1868, 181; Jordan, Ind. Geol. Surv., 1874, 224; Jordan, Bull. Buff. Soc. Nat. Hist., 1876, 94;

Jordan, Man. Vert., 1st ed., 1876, 275; 2d ed., 1878, 288; 3d ed., 1880, 288; Nelson, Bull. Ill. Lab. Nat. Hist., i, 1876, 45 (Bailey's Creek, Ill., Evanston, Ill.); Jordan & Copeland, Check List Fresh Water Fish. N. A., 1876, 146; Jordan, Bull U. S. Nat. Mus., ix, 1877, 32; Jordan, Annals N. Y. Acad. Sci., 1877, No. 4, 107 (Wisconsin R., Pecatonica R., Ohio R., Kentucky R.); Jordan, Bull. Ill. Lab. Nat. Hist., ii, 1878, 55 (Bailey's Cr.; Rock R., Ill.); Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 78 (Tributaries Cumberland R.); Jordan, Bull. Hayden's Geol. Surv., iv, 1878, 402, 419 and 783 (Rio Grande); Jordan, Rept. Geol. Surv. Ohio, iv, 1882, 839; Jordan & Gilbert, Synopsis Fish. N. A., 1883, 158; Bean, Cat. Fish. Internat. Fish Exhibition, London, 1883, 95 (Lake Beaver, Petersburgh).

Pimephales maculosus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 180 (Arkansas R.); Girard, Pac. R. R. Surv., x, 1858, 234 (Arkansas R.).

Pimephales fasciatus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 180 (Yellowstone R.; Milk R.); Girard, Pac. R. R. Surv., x, 1858, 234 (Yellowstone R.; Milk R.).

Hyborhynchus confertus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 179 (Pecos R.); Girard, Pac. R. R. Surv., x, 1858, 238 (Pecos R.); Jordan & Gilbert, Synopsis Fish. N. A., 1883, 159.

Plargyrus melanocephalus Abbott, Proc. Acad. Nat. Sci. Phila., 1860, 325 (Lake Whittelsey, Minn.).

Pimephales milesii Cope, Proc. Acad. Nat. Sci. Phila., 1864, 282 (Detroit R.); Günther, Cat. Fish. Brit. Mus., vii, 1868, 181 (copied); Nelson, Bull. Ill. Lab. Nat. Hist., i, 1876, 45; Jordan, Man. Vert., 1st ed., 1876, 276.

Pimephales agassizii Cope, Cyp. Penn., 1866, 394 (Whitewater R., Ind.); Jordan, Ind. Geol. Surv., 1874, 224.

Hyborhynchus nigellus Cope, Zool. Wheeler's Expl. W. 100th Mer., v, 671 (Arkansas R., Pueblo, Col.).

Pimephales nigellus Jordan, Bull. Hayden's Geol. Surv., iv, 1878, 664 Rio Grande R.).

Habitat.—Lake Champlain to the Upper Missouri, south to Tennessee and the Rio Grande. The species *H. confertus* Girard, is, in my opinion, not a distinct species, but only the western form of *promelas*, having the lateral line better developed.

2. Pimephales notatus.

Minnilus notatus Rafinesque, Ichth. Oh., 1820, 47 (Ohio R.).

Hyborhynchus notatus Agassiz, Amer. Jour. Sci. Arts, 1855, 223 (Frankfort, Ky.; Scioto R.; Quincy, Ill.; Burlington, Iowa; Lebanon, Tenn.; Natchez, Miss.; Beardstown and La Salle, Ill.; Rome, N. Y.; L. Huron, L. Champlain); Cope, Proc. Acad. Nat. Sci. Phila., 1864, 282; Cope, Jour. Acad. Nat. Sci. Phila., 1868, 265; Günther, Cat.

Fish. Brit. Mus., vii, 1868, 182 (Montreal; Kanawha R.); Cope, Cyp. Penn., 1866, 392; Jordan, Ind. Geol. Surv., 1874, 224 (L. Michigan, Ohio R.); Nelson, Bull. Ill. Lab. Nat. Hist., i, 1876, 45; Jordan, Man. Vert., 1st ed., 1876, 275; 2d ed., 1878, 288; 3d ed., 1880, 288; Jordan, Proc. Acad. Nat. Sci. Phila., 1877, 45 (Lakes, Laporte Co., Ind.; St. Joseph's R., Kankakee R., Tippecanoe R., Lower Wabash R., White R., Ind.); Jordan, Bull. U. S. Nat. Mus., ix, 1877, 27; Jordan, Annals N. Y. Lyc. Nat. Hist., xi, 1877, 373 (Rock Castle R., Ky.); Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 107 (L. Michigan, Fox R., Rock R., Wisconsin R., White R., Ohio R., Salt R., Rock Castle R.); Jordan, Bull. Ill. Lab. Nat. Hist., ii, 1878, 55 (Mackinaw Cr., Woodford Co.; McLean Co.; Rock R. at Oregon; Little Wabash, Effingham Co.; Ill. R., Peoria; Crystal Lake, McHenry Co., Ill.); Forbes, Bull. Ill. Lab. Nat. Hist., ii, 1878, 79 (Food of *Hyborhynchus notatus*); Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 63 and 78 (Chickamauga R., Cumberland R.); Hay, Proc. U. S. Nat. Mus., iii, 1880, 502 (Corinth, Miss.; Catawba Cr., Miss.; Noxubee R.); Hay, Bull. U. S. Fish Com., ii, 1882, 67 (Miss. R., Vicksburg; Big Black R., Yalabusha R., Tombigbee R., Chickasawha R.); Jordan, Rep. Geol. Surv. Ohio, 1882, iv, 840; Jordan & Gilbert, Synopsis Fish. N. A., 1883, 159; Bean, Cat. Fish. Internat. Fish Exhibition, London, 1883, 95 (Yellow Cr., Ohio); Jordan & Swain, Proc. U. S. Nat. Mus., 1883, 248 (Cumberland R., Ky.).

Pimephales notatus Gilbert, Proc. U. S. Nat. Mus., 1884, 200 (Salt Cr., Brown Co., Ind.).

Hyborhynchus perspicuus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 179 (Arkansan R.); Girard, Pac. R. R. Surv., x, 1858, 231 (Arkansas R.).

Hybognathus perspicuus Günther, Cat. Fish. Brit. Mus., vii, 1868, 185.

Hyborhynchus tenellus Girard, Proc. Acad. Nat. Sci. Phila., 1856, 179 (Arkansas R.); Girard, Pac. R. R. Surv., x, 1858, 231 (Arkansas R.).

? *Hyborhynchus puniceus* Girard, Proc. Acad. Nat. Sci. Phil., 1856, 179 (Canadian R.); Girard, Pac. R. R. Surv., x, 1858, 232 (Canadian R.).

Hyborhynchus superciliosus Cope, Jour. Acad. Nat. Sci. Phila., 1868, 234 (Kanawha R.); Jordan, Man. Vert., 1st. ed., 1876, 276; 2d ed., 1878; 289; 3d ed., 1880, 289; Jordan, Bull. U. S. Nat. Mus., ix, 1877, 27; Jordan, Bull. Ill. Lab. Nat. Hist., ii, 1878, 56 (Cache R. and Clear Cr., Union Co.; Rock R., Ogle Co., Ill.); Jordan & Gilbert, Synopsis Fish. N. A., 1883, 160; Jordan & Swain, Proc. U. S. Nat. Mus., 1883, 248 (Cumberland R.).

Habitat.—St. Lawrence River to Delaware; Ohio Valley and Great Lake Regions, southward to Tennessee and Mississippi. Very abundant.

The nominal species, *H. superciliosus* Cope, is, as has already been noted by Jordan and Swain, but a spring form of the breeding male of *notatus*.

A REVIEW OF THE AMERICAN ELEOTRIDINÆ.

BY CARL H. EIGENMANN AND MORTON W. FORDICE.

We have attempted to give in this paper the synonymy of the genera and species of *Eleotridinæ* found in the waters of America, with analytical keys by which they may be distinguished. All the specimens examined belong to the Museum of the Indiana University, most of them having been collected by Professor Jordan.

All the species are referred by Dr. Günther to a single genus, *Eleotris*. This group, however, seems to us rather of the nature of a subfamily. An examination of the skeletons of some of the species shows important differences, which we must regard as having generic value.

We place the American species in six genera, which may be characterized as follows:—

Analysis of Genera of Eleotridinæ.

Common Characters.—Ventral fins separate, each with one spine and five soft rays; dorsal spines six or seven.

a. Vomer with a broad patch of villiform teeth; isthmus very narrow; gill-openings extending forward below to posterior angle of mouth; teeth villiform, the outer scarcely enlarged; vertebræ, 12 + 13 (*dormitator*); skull above with conspicuous elevated ridges, one of these bounding orbit above; the orbital ridges connected posteriorly above by a strong cross-ridge; a sharp longitudinal ridge on each side of the occipital, the two nearly parallel, the post-temporals being attached to their posterior ends. Insertions of post-temporals widely separated, the distance between them greater than the rather narrow interorbital width; the post-temporal bones little divergent; top of head depressed, both before and behind the cross-ridge between eyes; a flattish triangular area between this and the little elevated supraoccipital region; preopercle without spines; lower pharyngeals with slender depressible teeth, and without lamelliform appendages; scales of moderate size, ctenoid. GOBIOMORUS. 1.

aa. Vomer without teeth; isthmus broad; gill-openings scarcely extending forward below to posterior angle of preopercle; skull without crests.

b. Body and head entirely scaly.

c. Lower pharyngeal teeth setaceous, the bones with an outer series of broad flexible lamelliform appendages or teeth; body short and elevated, cyprinodontiform; teeth slender, those in the outer row scarcely larger, and movable; top of head without raised crests, flattish, its surface uneven; post-temporal bones rather strongly diverging, the distance between their insertions about half the broad flattish interorbital space; no spine on preopercle or branchiostegals; scales large, ctenoid. Species herbivorous. DORMITATOR. 2.

cc. Lower pharyngeals normal, subtriangular, the teeth stiff, villiform, none of them lamelliform; scales of moderate or small size; body oblong or elongate.

d. Body moderately robust, the depth 4–5½ times in the length to base of caudal; cranium without distinct median keel; a small supraoccipital crest.

e. Post-temporal bones little divergent, not inserted close together, the distance between their insertions greater than the moderate interorbital space, or 3⅘ in length of head; top of skull little gibbous; interorbital region somewhat concave or channeled; lower pharyngeals narrower than in *Eleotris;* preopercle without spine; scales very small, ctenoid, about 100 in a longitudinal series. Vertebræ, 11 + 13; teeth moderate, the outer series enlarged. GUAVINA. 3.

ee. Post-temporal bones very strongly divergent, their insertions close together, the distance between them about ⅔ the narrow interorbital space, and less than ⅐ the length of the head; top of skull somewhat elevated and declivous; interorbital area slightly convex transversely; lower pharyngeals rather broad, the teeth bluntish; preopercle with partly concealed spine directed downward and forward at its angle; scales moderate, ctenoid, 45 to 60 in a longitudinal series. Vertebræ (*pisonis*) 11 + 15; teeth small.[1] ELEOTRIS. 4.

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[1] These characters of the skeleton are taken from *Eleotris pisonis*, and have not been verified on other species.

dd. Body very slender, elongate, the depth about $\frac{1}{8}$ the length to base of caudal; post-temporal bones short, strongly divergent, the distance between their insertions about equal to the narrow interorbital space, or about $\frac{1}{4}$ length of head; top of head with a strong median keel, which is highest on the occipital region; no supraoccipital crest; preopercle without spine; mouth very oblique; the teeth small; scales very small, cycloid. EROTELIS. 5.

bb. Body naked on the anterior part; head naked; lower jaw with four larger recurved teeth. GYMNELEOTRIS. 6.

1. GOBIOMORUS.

Gobiomorus Lacépède, Hist. Nat. Poiss., ii, 599, 1798 (*dormitor*, etc.).
Philypnus Cuvier & Valenciennes, Hist. Nat. Poiss., xii, 255, 1837 (*dormitator*).
Lembus Günther, Cat. Fish. Brit. Mus., i, 505, 1859 (*maculatus*).
Gobiomorus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 571 (restricted to *dormitator*).

This genus is well characterized by the presence of vomerine teeth, and by the narrowness of the isthmus. Equally good characters may be taken from the cranium, which is provided with elevated, longitudinal and transverse ridges, which are not found in any other of our genera of this type. The species reach a larger size than those of our other genera.

The reasons for preferring the name *Gobiomorus* to *Philypnus* have been given in detail by Jordan and Gilbert (*loc. cit.*).

Analysis of Species of Gobiomorus.

Common Characters.—Body elongate; the head somewhat depressed; body compressed behind. Scales ctenoid; 55 to 66 in a longitudinal series. Dorsal with 7 spines and 9 or 10 rays; anal rays I, 9 or 10; lower jaw considerably projecting; teeth in jaw rather small, slender, recurved, the outer scarcely enlarged; teeth on vomer villiform, in a broad crescent-shaped patch; gill-openings extending forward to below posterior angle of mouth, the isthmus being very narrow. No preopercular spine; insertion of post-temporals almost midway between occipital crest and edge of skull; parietals with a crest running from insertion of post-temporal forward to just behind eye, where they are connected

by a thin, high, transverse crest; supraocular with a short high crest, extending from above front of eye back to posterior edge of orbit, thence extending outward parallel with the transverse crest, leaving a deep groove between them; bony projectious before and behind eye prominent. Vert. 12+13 (*dormitator*); lower pharyngeals triangular, with slender teeth.

a. Scales large, 55 in a longitudinal series; 28 scales on median line between occiput and front of spinous dorsal. Body robust; depth 4 in length; head 2¾. D. VI–1, 9; A. I–10; crests on skull very high. *Lateralis*. 1.

aa. Scales moderate, 57 to 66 in longitudinal series; head 3 to 3½ in length; depth 5 to 6.

b. Scales in median line from occiput to front of spinous dorsal 26; head 3½ in length; transverse frontal crest not continuous. D. VI–1, 9; A. I–10; 57 to 60 scales in a longitudinal series. *Maculatus*. 2.

bb. Scales on median line from occiput to spinous dorsal 35; transverse frontal crest continuous.

c. Scales medium, 57 to 60 in a longitudinal series; head 3¼ in length; depth 5½. D. VI–1, 9; A. I–9; crests on skull moderate. *Dormitator*. 3.

cc. Scales smaller, 66 in a longitudinal series; depth 6 in length; head 3. D. VI–1, 10. *Longiceps*. 4.

1. **Gobiomorus lateralis.**

Philypnus lateralis Gill, Proc. Acad. Nat. Sci. Phila., 1860, 123 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 232 (West Coast Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 368 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 372 (Colima); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 377 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 380 (San José).

Eleotris lateralis Günther, iii, 122, 1861 (Cape San Lucas).

Habitat.—Pacific Coast of America, from San José to Panama.

This species represents on the Pacific Coast the *G. dormitator* of the Atlantic. It is readily distinguished by its shorter body, larger scales, and by the greater development of its cranial crests.

2. **Gobiomorus maculatus.**

Lembus maculatus Günther, Cat. Fish. Brit. Mus., i, 505, 1859 (Andes of Ecuador); Günther, Proc. Zool. Soc. Lond., 1860, 236 (Ecuador, Esmeraldas).

Eleotris lembus Günther, Cat. Fish. Brit. Mus., iii, 121, 1861 (Ecuador).

Habitat.—Streams of Ecuador.

This species is known to us only from the descriptions of Dr. Günther.

3. **Gobiomorus dormitator.**

Guavina Parra, Descr. Dif. Piezas Hist. Nat. Cuba, tab. 39, fig. 1, 1787 (Havana; fide Poey).

Gobiomorus dormitor Lacépède, Hist. Nat. Poiss., ii, 599, 1798 (from a drawing by Plumier).

Gobiomorus dormitator Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 572 (name only).

Platycephalus dormitator Bloch, Syst. Ichth., Plate xii, 1790 (Martinique); Bloch & Schneider, Syst. Ichth., 60, 1801.

Eleotris dormitatrix Cuvier, Règne Animal, ed. ii, 1829 (Antilles); Oken, Naturgeschichte, vi, 178, 1836; Günther, iii, 119, 1861 (Barbadoes, Jamaica, Mexico).

Philypnus dormitator Cuvier & Valenciennes, xii, 255, 1837 (Porto Rico, San Domingo, Martinique); Poey, Mem. de Cuba, ii, 381, 1856 (Cuba); Girard, U. S. and Mexican Boundary Survey, 27, plate xii, fig. 13, 1859 (Rio Grande); Poey, Syn. Pisc. Cub., 395, 1868 (Cuba); Poey, Enum. Pisc. Cub., 128, 1875 (Mexico, Rio Grande, San Domingo, Martinique, Jamaica); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 236 (name only); Jordan & Gilbert, Syn. Fish. N. A., 631, 1882.

Batrachus guavina Bloch & Schneider, Syst. Ichth., 44, 1801 (based on *Guavina* of Parra).

Habitat.—Rio Grande to Martinique, in fresh waters.

This species is generally common in the streams of the West Indies and Eastern Mexico. We follow later writers in changing the incorrectly spelled *dormitor* of Lacépède to *dormitator*. According to Poey, the type of Parra's *Guavina*, still preserved in the Museum at Madrid, has teeth on the vomer, and is therefore a *Gobiomorus*, not a *Guavina*. The many specimens examined by us are from Havana.

4. **Gobiomorus longiceps.**

Eleotris longiceps Günther, Proc. Zoöl. Soc. Lond., 1864, 151; Günther, Fish. Central America, 1869, 440 (Nicaragua).

Habitat.—Lake Nicaragua.

This species is known to us only from Dr. Günther's description.

2. DORMITATOR.

Prochilus Cuvier, Règne Animal, ed. i, 1817 (*mugiloides*), (preoccupied).
Dormitator Gill, Proc. Acad. Nat. Sci. Phila., 1862, 240 (*gundlachi* = *maculatus*).

This genus is not adopted by Dr. Günther, but it seems to us well founded, its peculiarities in dentition being important. The name *Prochilus* at first given to this group is preoccupied by *Prochilus* of Illiger, a genus of mammalia, as well as by the prebinominal *Prochilus* of Klein, which belongs to the Pomacentridæ.

The known species of this type are very closely related and should perhaps be regarded as geographical varieties of a single one.

Analysis of the Species of Dormitator.

Common Characters.—Body short, robust; head broad and flat above; mouth little oblique; maxillary reaching to anterior margin of orbit; lower jaw little projecting; no teeth on vomer; scales large, ctenoid, 30 to 33 in a longitudinal series; skull much as in *Eleotris*, but everywhere broader. D. VII–1, 8; A. I, 9 or 10; no spine on preopercle; post-temporals inserted midway between occipital crest and edge of skull; supraoccipital crest low.

a. Scales large, becoming much smaller on belly; 25 series on a median line from base of ventrals to vent; 18 series across breast from pectoral to pectoral; 18 on a median line from posterior border of orbit to dorsal. Interspace between dorsals equal to orbit. Highest anal ray 1⅗ in head; highest dorsal ray 1⅓ in head. 33 scales in a longitudinal series. *Maculatus.* 5.

aa. Scales larger than in *maculatus*, not much smaller on belly; 18 series on a median line from ventrals to vent; 13 series from pectoral to pectoral; 16 on a median line from posterior border of orbit to front of soft dorsal; interspace between dorsals less than diameter of orbit. Highest anal ray 1½ in head; highest dorsal ray equals head. 31 scales in a longitudinal series. *Latifrons.* 6.

5. **Dormitator maculatus.**

Sciæna maculata Bloch, "Ichth., tab. 299, f. 2," 1790 (West Indies); Bloch & Schneider, Syst. Ichth., 80, 1801 (copied).

Eleotris maculatus Günther, iii, 112, 1861 (West Indies; Trinidad; Demerara); Günther, Fish. Cent. Am., 440, 1869 (Anamahal).

Dormitator maculatus Goode & Bean, Proc. U. S. Nat. Mus., 1882, 236 (Gulf of Mexico).

Eleotris mugiloides Cuvier & Valenciennes, xii, 226, 1837 (Martinique; Surinam).

Eleotris somnolentus Girard, Proc. Acad. Nat. Sci. Phila., 1858, 169 (Rio Grande); Girard, U. S. and Mex. Bound. Survey, 28, pl. 12, f. 1–3, 1859 (Rio Grande); Günther, iii, 557, 1861 (Cordova).

Dormitator somnolenta Poey, "Repert., ii, 168," 1868; Poey, Enum. Pisc. Cuben., 128, 1875 (Cuba).

Eleotris omocyaneus Poey, Memorias, ii, 269, 1860 (Havana).

Dormitator omocyaneus, Poey, Syn. Pisc. Cuben., 296, 1868 (Cuba); Poey, Enumer. Pisc. Cuba, 128, 1875 (Cuba).

Eleotris gundlachi Poey, Mem., ii, 272, 1860 (Cuba).

Dormitator gundlachi Poey, Syn. Pisc. Cuben., 396, 1868 (Cuba); Poey, Enum. Pisc. Cub., 128, 1875 (Cuba).

Dormitator lineatus Gill, Proc. Acad. Nat. Sci. Phila., 1863, 271 (Savannah).

Habitat.—East Coast of America; South Carolina, Texas, Louisiana, south to Surinam; chiefly in fresh water.

As Cuvier and Valenciennes have identified the type of Bloch's *Sciæna maculata* with their *Eleotris mugiloides*, we adopt the latter name for this species. We are unable to distinguish the *somnolentus* of Girard from *maculatus*, and the *omocyaneus* of Poey is certainly the same. Gill's *lineatus* is also, doubtless, a young example of the same type.

We find nothing (unless it be the greater height of the fins) in the description of *Eleotris gundlachi* Poey, by which it can be distinguished from *Dormitator maculatus*. Poey's type was about 8 inches in length, and its large size may account for the slight differences indicated.

The single specimen studied by us is from the West Indies.

6. **Dormitator latifrons.**

Eleotris latifrons Richards, "Voy. Sulph. Fishes, 57, pl. 35, f. 4–5," 1837 (Pacific Coast Central America).

Eleotris maculata Günther, iii, 112, 1861 (Guayaquil), (not *Sciæna maculata* of Bloch).

Dormitator sp., Bean, Proc. U. S. Nat. Mus., 1880, 83 (Colima).

Dormitator maculatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 232 (Salina Cruz); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 368 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 372 (Colima); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 377 (Panama); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 380 (Cape San Lucas); Jordan & Gilbert, Bull. U. S. Fish. Com., 1882, 108 (Mazatlan); Jordan & Gilbert, Syn. Fish. N. A., 1883, 632 (Mazatlan).

Dormitator microphthalmus Gill, Proc. Acad. Nat. Sci., Phila., 1863, 170 (Panama).

Habitat.—Pacific Coast of Central America, from Cape San Lucas southward to Panama.

This species is abundant on the Pacific slope of Mexico and Central America. It differs from *D. maculatus* in few respects, and should, perhaps, be regarded as a variety of the latter. They have, however, not yet been shown to intergrade.

3. GUAVINA.

Guavina Bleeker, Esquisse d'un Syst. Nat. Gobioid., 302, 1874 (*guavina*).

This genus is externally distinguished from *Eleotris* only by the absence of preopercular spine, and by the smaller size of the scales. The skulls in the two genera are, however, strikingly different, and we think that the two groups should be regarded as generically distinct. We know only one species of this genus.

Analysis of Species of Guavina.

a. Body stoutish, oblong; mouth oblique; maxillary reaching opposite middle of eye, its length about 3½ in head. Lower jaw little projecting. Teeth in broad bands, the outer ones enlarged. Scales on head imbedded; those on body very small, ctenoid on sides, cycloid on back and belly, 100 to 110 in a longitudinal series. Isthmus very broad. Pectorals reaching to middle of spinous dorsal. Highest anal ray 1⅜ in head. Head 3⅓ in length to base of caudal; depth 4⅓ to 5¼. D. VI, I, 10; A. I, 9 or 10. Post-temporals inserted twice as far from occipital crest as in *Eleotris pisonis*. Parietals ending in a sharp point behind. Preopercular spine none; a broad thin extension on the lower limb of preopercle taking its place. Lower pharyngeals triangular, normal, rather narrow; the teeth small. Vomer without teeth. *Guavina.* 7.

7. **Guavina guavina.**

Eleotris guavina Cuvier & Valenciennes, xii, 223, 1837 (Martinique); Günther, iii, 124, 1861 (Demarara); Poey, "Repert. i, 337, 1867;" Poey, Syn. Fish. Cuba, 395, 1868 (Cuba); Poey, Enum. Pisc. Cuba, 127, 1875 (Cuba).

Habitat.—East Coast of tropical America, West Indies, south to Surinam, in fresh waters.

This species is abundant in the streams of Cuba. The numerous specimens examined by us were obtained by Prof. Jordan in the Rio Almendares, near Havana. In life this species may be readily distinguished from *Eleotris pisonis*, which abounds in the same waters, by the bright cherry-colored edgings to its ventrals and anal.

4. ELEOTRIS.

Eleotris "Gronow, Mus. Ichthyol., 16," 1757 (Non-binominal).
Eleotris Bloch & Schneider, Syst. Ichth., 65, 1801 (*pisonis*).
Eleotris Cuvier & Valenciennes, xii, 216, pl. 356, 1837 (*gyrinus*).
Culius Bleeker, Esquisse d'un Syst. Nat. des Gobioides, 308, 1874 (*fuscus*).

As *Eleotris pisonis* possesses the preopercular spine assumed to characterize the genus *Culius*, we place the latter name in its synonymy. In large specimens of *Eleotris pisonis*, this spine is somewhat concealed by the flesh, but it may always be found by dissection. The four following species resemble each other very closely, and probably agree in the structure of the skeleton, but in this regard we have been able to examine only *Eleotris pisonis*.

Analysis of Species of Eleotris.

a. **Body comparatively robust; head broad, depressed; body compressed; mouth oblique, lower jaw little projecting; maxillary reaching to below eye; scales ctenoid, 46 to 61 in longitudinal series. Dorsal rays, VI–I, 8; anal rays, I, 7 or 8. Vomer without teeth. Gill-openings extending forward below to angle of preopercle; isthmus broad. Preopercle with a spine projecting downward and forward at its angle. Post-temporals slender, widely diverging, inserted very near the scarcely evident occipital crest. Skull highest in the middle, very broad and short; bony projections in front of and behind eye prominent. Vertebræ about 10 + 14 (*pisonis*). Lower pharyngeals subtriangular, rather broad, with comparatively coarse teeth.**

b. **Scales large, about 48 in longitudinal series; depth $4\frac{1}{2}$ in length to base of caudal; head $3\frac{1}{2}$. D. VI, 9; A. I, 8; teeth rather small, those of the inner series in each jaw largest.** ***Amblyopsis*. 8.**

bb. Scales moderate, about 60 in lateral series. D. VI–I, 8; A. I, 7 or 8.

c. Body comparatively robust; depth 4 to 5 in length; teeth in jaws all small, subequal. *Pisonis*. 9.

cc. Body comparatively slender; depth 6 in length; head $3\frac{1}{2}$.

d. Teeth in jaws all small, subequal. *Æquidens*. 10.

dd. Teeth in jaws unequal, some of those in the outer row enlarged. *Belizana*. 11.

8. Eleotris amblyopsis.

Culius amblyopsis Cope, Proc. Am. Phil. Soc., 1870, 473 (Surinam); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 236 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 610 (Charleston); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 619 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 1882, 944.

Habitat.—Atlantic coast of America, from Charleston to Surinam.

Only three specimens of this species are yet known. It is well distinguished from its congeners by its larger scales.

9. Eleotris pisonis.

Eleotris capite plagioplateo, etc. "Gronow, Mus. Ichth., ii, n. 168," 1757.

Gobius pisonis Gmelin, Syst. Nat. 1206, 1788 (based on *Eleotris* of Gronow).

Eleotris pisonis Bloch & Schneider, Syst. Ichth., 68, 1801 (based on *Eleotris* of Gronow).

Gobius pisonis Turton, Syst. Nat., 751, 1807 (South America).

Gobius amorea Walbaum, Artedi Piscium, iii, 205, 1792 (based on *Eleotris* of Gronow).

Eleotris gyrinus Cuvier & Valenciennes, xii, 220, 1837, Pl. 356 (Martinique, San Domingo, Surinam); Girard, U. S. and Mexican Boundary Survey, 28, Pl. xii, figs. 11–12, 1859 (Rio Grande); Günther, Catalogue Fish. in Brit. Mus., iii, 122, 1861; Poey, "Repert., i, 336," 1867; Poey, Syn. Pisc. Cubens., 395, 1868 (Cuba); Poey, Enumer. Pisc. Cub., 127, 1875 (Cuba); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 571 (name only); Jordan & Gilbert, Syn. Fish. N. A., 631, 1883.

Eleotris picta Kner & Steindachner, Abhandl. bayer. Ak. Wiss., 1864, 18, Pl. 3, fig. 1 (Rio Bayano, near Panama).

Culius perniger Cope, Proc. Am. Phil. Soc., 1870, 473 (St. Martins).

Habitat.—Both coasts of Central America, north to Cuba and Texas, chiefly in fresh waters.

The *Gobius pisonis* of Gmelin and its synonym, *Gobius amorea* of Walbaum, are based on the *Eleotris* of Gronow. This is undoubtedly identical either with *Eleotris gyrinus* or *Guavina guavina*. To us there is little doubt that the former species was the one intended, as the phrase "P. D. prior declinata 6 radiata; secunda equalis, priori vicina" applies well to the *Eleotris gyrinus* and not at all to the *Guavina guavina*, in which species the second dorsal is much larger than the first. We therefore adopt the name *Eleotris pisonis* instead of *Eleotris gyrinus*.

We have examined numerous specimens of this species from the Rio Almendares, near Havana. All these possess the antrorse preopercular spine supposed to distinguish the genus *Culius* from *Eleotris*. In the larger ones it is partly hidden by the encroachment of the skin and from this has arisen the erroneous supposition (of Günther and others) that this species is one in which the spine is wanting.

A comparison of the figure and description of *Eleotris picta*, given by Kner and Steindachner, shows no constant point of difference whatever. We therefore regard *picta* as a synonym of *pisonis*.

The *Culius perniger* of Cope is evidently identical with *pisonis*, Professor Cope being the first describer of the species who did not overlook the preopercular spine.

10. **Eleotris æquidens.**

Eleotris sp., Bean, Proc. U. S. Nat. Mus., 1880, 88 (name only).
Culius æquidens Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 461 (Mazatlan); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 372 (Colima); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 380 (Cape San Lucas, San José); Jordan & Gilbert, Bull. U. S. Fish Com., 1882, 108 (Mazatlan).

Habitat.—Streams about the Gulf of California, south to Colima.

This species is known to us from the original description by Jordan and Gilbert; it is said to be abundant in the streams of Sinaloa and Lower California.

11. **Eleotris belizana.**

Culius belizanus Sauvage, "Bull. Soc. Philom. Paris, 1879, 16 (reprint)" (Belize); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 462 (foot-note).

Habitat.—Belize.

This species is known to us only from a foot-note by Jordan and Gilbert, referring to the description by M. Sauvage. It is said to differ from *E. æquidens*, by having the teeth of the outer row enlarged.

5. EROTELIS.

Erotelis Poey, Memorias de Cuba, ii, 273, 1861 (*valenciennesi* = *smaragdus*).

This genus differs from the others in having the scales small, cycloid, the body long, slender, and the tail lanceolate. In form this genus differs strikingly from *Eleotris*, its nearest ally. It presents a strong analogy to *Gobionellus*, differing from *Eleotris* much as the latter does from *Gobius*.

But one species seems to be known.

Unlike the other *Eleotridinæ*, this is strictly marine, inhabiting the coarse algæ on the coral reefs.

Analysis of Species of Erotelis.

a. Body long, slender; depth about $\frac{1}{8}$ the length to base of caudal; head broad, depressed; mouth large, very oblique, the lower jaw projecting. Maxillary reaching to below centre of eye, its length, $2\frac{1}{2}$ in head. Vomer without teeth; teeth on jaws small, equal. Scales small, cycloid, about 100 in a longitudinal series, largest on caudal peduncle. Caudal fin lanceolate; caudal peduncle slender, 3 in length of body. D. VI–1, 9; A. I–9. Gill-openings extending forward to below centre of opercle. Post-temporals diverging, inserted near occipital crest, which is obsolete. Skull uneven and rather thick. Preopercular spine absent. Vertebræ 10+15. Pectorals reaching past middle of first dorsal. Dorsal and anal high; highest anal ray $1\frac{1}{3}$ in head. *Smaragdus.* 12.

12. Erotelis smaragdus.

Eleotris smaragdus Cuvier & Valenciennes, xii, 231, 1837 (Cuba); Guichenot, "Poiss. in Ramon de la Sagra, Hist. Cuba, 130," 1855; Günther, Cat. iii, 123, 1861 (Cuba); Jordan, Proc. U. S. Nat. Mus., 1884, 141 (Key West).

Erotelis valenciennesi Poey, Mem. de Cuba, ii, 173, 1861 (Cuba); Poey, Syn. Pisc. Cub., 396, 1868 (Cuba); Poey, Enum. Pisc. Cub., 127, 1875 (Cuba).

Habitat.—Florida Keys to Cuba; strictly marine, not ascending rivers.

This species is rather abundant on the coast of Cuba. A single specimen was obtained by Professor Jordan at Key West. It reaches a length of about a foot. It is confounded by Cuban fishermen with the Esmeralda (*Gobionellus*), although it lacks the emerald-colored prominences on the tongue. From this confusion the not appropriate name of *smaragdus* has come to be given to this species. This Poey has proposed to change to *Valenciennesi*; but this change the law of priority forbids.

6. GYMNELEOTRIS.

Gymneleotris Bleeker, Esquisse d'un Syst. Nat. des Gobioides, 304, 1874 (*seminuda*).

The distinguishing mark of this genus seems to be the absence of scales on the head and anterior part of the trunk. Nothing is known either of the genus or of its single species, except what is contained in Günther's description of the latter.

Analysis of the Species of Gymneleotris.

a. Head and trunk naked; tail covered with small scales; head ⅓ of total length; maxillary extending to below anterior margin of orbit. Teeth in upper jaw in a narrow band; the lower has four somewhat larger and recurved teeth in front; palate toothless. Fin-rays not prolonged. Pectorals not quite extending to origin of second dorsal. Ventrals much shorter than pectoral. D. VII, 11; A. 9.

Seminuda. 13.

13. **Gymneleotris seminuda.**

Eleotris seminuda, Günther, Proc. Zoological Soc., London, 1864, 24, "Plate iv, f. 2, 2 *a*" (Pacific Coast of Panama); Günther, Fish. Central America, 441, 1869.

Gymneleotris seminuda Bleeker, Esquisse d'un Systema Nat. Gobioides, 304, 1874.

This species is known from the description by Dr. Günther of a small specimen in the British Museum.

List of Nominal Species of Eleotridinæ, arranged in Chronological Order, with Identifications.

(Tenable Specific Names are in Italics.)

Nominal Species.	*Date.*	*Identification.*
Gobius *pisonis* Gmelin,	1788,	Eleotris pisonis.
Sciæna *maculata* Bloch,	1790,	Dormitator maculatus.
Gobius amorea Walbaum,	1792,	Eleotris pisonis.
Gobiomorus *dormitor* Lacépède,	1798,	Gobiomorus dormitator.
Platycephalus *dormitator* Bloch & Schneider,	1801,	" "
Batrachus guavina Bloch & Schneider,	1801,	" "
Eleotris mugiloides Cuvier & Valenciennes,	1837,	Dormitator maculatus.
Eleotris *guavina* Cuvier & Valenciennes,	1837,	Guavina guavina.
Eleotris gyrinus Cuvier & Valenciennes,	1837,	Eleotris pisonis.
Eleotris *smaragdus* Cuvier & Valenciennes,	1837,	Erotelis smaragdus.
Eleotris *latifrons* Richardson,	1837,	Dormitator latifrons.
Eleotris somnolentus Girard,	1858,	Dormitator maculatus.
Lembus *maculatus* Günther,	1859,	Gobiomorus maculatus.
Philypnus *lateralis*, Gill,	1860,	Gobiomorus lateralis.
Eleotris omocyaneus Poey,	1860,	Dormitator maculatus.
Eleotris gundlachi Poey,	1860,	" "
Erotelis valenciennesi Poey,	1861,	Erotelis smaragdus.
Dormitator lineatus Gill,	1863,	Dormitator maculatus.
Dormitator microphthalmus Gill,	1863,	Dormitator latifrons.
Eleotris *longiceps* Günther,	1864,	Gobiomorus longiceps.
Eleotris *seminuda* Günther,	1864,	Gymneleotris seminuda.
Eleotris picta, Kner & Steindachner,	1864,	Eleotris pisonis.
Culius *amblyopsis* Cope,	1870,	Eleotris amblyopsis.
Culius perniger, Cope,	1870,	Eleotris pisonis.
Culius *belizanus* Sauvage,	1879,	Eleotris belizana.
Culius *æquidens* Jordan & Gilbert,	1881,	Eleotris æquidens.

Recapitulation.

In this review we have admitted 13 species and 6 genera of *Eleotridinæ* as probably valid. We give here a list of the species. The general distribution of the species is indicated by the letters W. (Western Atlantic, West Indies, etc.); U. (Coast of United States); P. (Eastern Pacific, Mazatlan, Panama, etc.); G. (Western slopes of South America).

Subfamily Eleotridinæ.

Genus 1. GOBIOMORUS Lacépède.

1. **Gobiomorus lateralis Gill (P.).**
2. **Gobiomorus maculatus Günther (G.). (Species unknown to us.)**
3. **Gobiomorus dormitator Lacépède (W. U.).**
4. **Gobiomorus longiceps Günther (W.).**

Genus 2. DORMITATOR Gill.

5. Dormitator maculatus Bloch (U. W.). (Possibly more than one species in our synonymy.)
6. Dormitator latifrons Richardson (P.). (Possibly a variety of maculatus.)

Genus 3. GUAVINA Bleeker.

7. Guavina guavina Cuvier and Valenciennes (W.).

Genus 4. ELEOTRIS (Gronow) Bloch & Schneider.

8. Eleotris amblyopsis Cope (U. W.).
9. Eleotris pisonis Gmelin (W. P.). (Possibly two species contained in the synonymy.)
10. Eleotris æquidens Jordan and Gilbert (P.).
11. Eleotris belizana Sauvage (W.). (Unknown to us.)

Genus 5. EROTELIS Poey.

12. Erotelis smaragdus Cuvier and Valenciennes (U. W.).

Genus 6. GYMNELEOTRIS Bleeker.

13. Gymneleotris seminuda Günther (P.). (Unknown to us.)

ENTOMOLOGIA HONGKONGENSIS.—REPORT ON THE LEPIDOPTERA OF HONGKONG.

BY F. WARRINGTON EASTLAKE.

The province of Kwangtung, to which the island of Hongkong properly belongs, has long been celebrated throughout the Chinese Empire for the beauty and great variety of the insects to be found within its borders. The soil is, in most parts, exceptionally rich, and teems with an ever-busy world of animal life. But, great as is the fecundity of the larger part of the province, there are, here and there, sandy, arid wastes, which even the untiring labor of the native agriculturists fails to make yield more than the scantiest of crops. This is especially the case along the southeastern littoral. Here the formation is igneous and the rocks granitic, as a rule, with occasional intrusive traps and seams of trachytic porphyry. The island of Hongkong, in particular, consists mainly of hornblendic granite, of which silica, alumina, and various oxides of iron are the principal components. The rock is, at the same time, composed throughout of materials unusually susceptible to climatic influences, particularly to the action of heavy rains. The decomposed and disintegrated rock makes an admirably fertile soil, especially in the ravines, valleys, and lowlands; the hills, however, being constantly exposed to all sorts of weather, are signally barren and verdureless. Tufts of "arrow-grass," long, trailing mosses, coarse ferns and hardy flowering-plants are sparsely scattered over the mountain-slopes; pines, firs, and a few other resinous trees cover the less-exposed portions, but the heavy rains annually sweep down quantities of this local vegetation into the sea. In such places insect life is rare. And yet the entomology of Hongkong, although so small an island, is unusually rich and worthy of attention. This is chiefly due to the fact that the island is connected with the famous Lo-fan Shan —a small range of mountains some fifteen miles north of the thriving market-town of *Shek Lung* ("Stone Dragon,") and about seventy miles east of Canton. Starting from the westernmost spur of this range, a limestone formation runs to the north and northwest. Here the flora is both beautiful and luxuriant; flowering plants laden with tempting pollen cover the hillsides,

and insects find in the verdant groves a veritable paradise. The Lo-fan Mountains besides this, probably owing to their majestic scenery and rich flora, have for more than ten centuries enjoyed a reputation of great sanctity. In the deep caves and mountain forests of the Lo-fan, hermits, sages and priests have lived and taught their disciples from time immemorial; while, in accordance with both Buddhistic and Taoistic precepts, all animals, birds, reptiles, insects, and even the delicious trout of the mountain-streams have been kept from harm and allowed to breed undisturbed. Passing through the thickly populated districts of Pok-lo and Tong-kun, a low, undulating range of hills connects the Lo-fan with the mountainous country opposite Hongkong. And hence it comes that the entomology of the island is so extensive and varied.

Hongkong lies between 22° 9′ and 22° 1′ north latitude, and 114° 5′ and 114° 18′ east longitude; the island is, therefore, just inside the tropics, but near enough to the boundary to enjoy fine, temperate weather from September to April. To a considerable extent, the insular fauna shows close relationship with the fauna of the tropics; and yet there can be no doubt that some few of the tropical features are not characteristic of Hongkong. To this category belong notably *Python reticulatus*, Gray, the rock python of India, and the venomous cobra, *Naja tripudians*, Merr.; very possibly, also *Macrochlamys superlita*, Morelet—a fine land snail. The Lepidoptera, however, are very distinctly related to the entomic fauna of the Himalayas, East India, and the Malayan Archipelago. During a stay of several years in Hongkong, the writer devoted much time and attention to the study of the insular fauna, and formed large collections of the lepidoptera and terrestrial mollusks. In the spring of 1883, the writer published a work on Hongkong, in which a short list of the diurnal Lepidoptera was given. But this list was necessarily incomplete, as the writer had not enjoyed any opportunity of subjecting his collections to competent scientific inspection and classification. Since then, thanks to several important works which have appeared on the Insect Fauna of various parts of Asia, the writer has been enabled to compile the following list in a far more thorough manner. Outside of Donovan's "Insects of China"—which will be mentioned later on—no work has ever been published on the entomology of China, and, beyond a few chapters in the

journals of passing naturalists, the enumeration and description of the Hongkong insects have been entirely neglected. Despite this fact, a rich field there awaits the collector and the scientist, as the beetles, butterflies and moths are often of exceptional size and great beauty. An *Attacus* (male) in the writer's possession measures no less than eleven and one-half inches across the wings. Of beetles alone—according to Frauenfeld—Mr. John Bowring (son of Governor Bowring, of Hongkong), collected more than twelve hundred species, many of which were new to science.

In compiling the following list, the entomology of various other localities throughout the province of Kwangtung has been taken into special consideration. Notably that of the other islands in the Ladrones group of the Lo-fan Mountains—where some time was spent in collecting—and of Macao. In the latter port the writer passed several months, and succeeded in making valuable collections, thanks to the courtesy of Governor da Graça, who did everything in his power to facilitate the work. A complete catalogue and description of the collections then made have since been embodied in a work entitled "Fauna Macanensis," recently forwarded to the Portuguese Government. It is somewhat difficult to keep the entomology of Hongkong entirely distinct from that of adjacent islands and mainland. As has already been stated, the hills opposite Hongkong practically introduce the insect fauna of the entire Kwangtung Province. At times, months or even years may pass before the reappearance of a certain species; and then a favorable wind may waft it unexpectedly into the flower-gardens of Victoria, there, mayhap, to completely puzzle the brains of some ardent entomologist. In the following list, however, all doubtful species have been so far as possible excluded, and only such admitted as have been identified by scientists of acknowledged ability.

Reference has been made to the following works:—

Donovan, A. The Insects of China, 2d ed., 1842 (Westwood).

Frauenfeld. Die Novara Expedition, Sitzungsber. d. mathem. naturw. Cl. K. K. Acad. d. Wissensch., Wien, xxxv, 1859, 10.

Butler, A. Lepidoptera Heterocera in the British Museum, Pts. ii, iii, 1878.

Elwes, H. J. Butterflies of Amurland, North China and Japan. Proc. Zoolog. Soc. London, 1881.

Distant, W. L. Rhopalocera Malayana, Pts. i–v, London and Penang, 1882.

Pryer, H. A Catalogue of the Insects of Japan, Trans. Asiatic Soc. of Japan, 1883.

Donovan's "Insects of China" is a mere primer on the vast subject included in its title, and very incorrect at that. Since his day, entomological nomenclature has undergone many changes, and even the classification of genera and species has not been left undisturbed. For the sake of completeness, however, it is perhaps advisable to append the meagre list of Lepidoptera, which Donovan notes as coming from Hongkong. It includes but fifteen butterflies and four moths :—

Papilio paris, Linn.
Papilio agenor, Linn.
Papilio agamemnon, Linn.
Papilio epius, Jones.
Papilio demetrius, Linn.
Pieris hyparete, Linn.
Pieris (*Iphias*) *glaucippe*, Linn.
Pieris (*Thestias*) *pyrene*, Linn.
Argynnis eurymanthus, Drury.
Cynthia orithya, Linn.
Cynthia œnone, Linn.
Cynthia almana, Linn.
Limenitis leucothoe, Linn.
Limenitis eurynome, Linn.
Thecla mæcenas, Jones.

Sesia hylas, Linn.
Glaucopis polymena, Linn.
Phalæna attacus.
Saturnia atlas, Linn.
(*Eusemia lectrix*, Linn., doubtful.)

In Mr. H. J. Elwes' list I find further one butterfly mentioned as coming from Southern China, which I have never met with in Hongkong. This is *Thaumantis howqua*, Westwood, named probably after that rich Cantonese merchant so well known twenty or thirty years ago. Those marked with an asterisk (*) in the following list are contained in the writer's collection, but several others in this collection have still to be identified.

*Papilio xuthus, Linn. (*xuthulus*, Linn.).

This insect occasionally finds its way to Hongkong, but is tolerably numerous around Canton and further north, and abundant in Japan. The imago invariably appears under the xuthulus form in the spring. The female is dimorphic, it feeds on various kinds of *Citrus*, especially *C. trifoliata*.

*Papilio maackii, Men. (*Dehaani*, Feld.).

Very frequent in the Lo-fan Mountains; less so in Hongkong. Found also in North China and Japan.

***Papilio helenus**, Linn.

Rare; has been taken also in Shanghai and Nagasaki.

***Papilio pamnon**, Linn.

This gorgeous butterfly is not uncommon about May, and continues to visit the island from time to time until September.

***Papilio memnon**, Linn.

This is one of the largest of the Hongkong Lepidoptera. The markings of the female are totally different from those of the male, which is altogether a smaller insect. Also Southern Japan.

***Papilio sarpedon**, Linn.

Quite common throughout the year. North China and Japan.

***Papilio demetrius**, Cramer.

Occasionally seen in autumn. Common in Japan.

***Papilio paris**, Linn.

Abundant. A beautiful insect, always to be found near *Hyliscus rosa sinensis*.

Papilio clytia, Linn. (var. *dissimilis*, Swainson).
***Papilio panope**, Linn.
Papilio polytes, Linn.
***Papilio agenor**, Linn. (var. *alcanor*, Cramer).
***Papilio bianor**, Cramer.
***Pieris rapæ**, Linn. (*crucivora*, Butler).

One of the commonest butterflies; found all the year round. In markings and size it is very variable. As a rule, it feeds on cultivated *Cruciferæ*.

***Pieris napi**, Linn. (*megamera*, Butler; *melete*, Men.),
Pieris canidia, Sparrm.
***Tereias multiformis**, H. Pryer (*Hecabe*, Linn.; *mandarina*, De l'Orza; *hecabeoides*, Men.; *sinensis*, Sue; *Mariesi*, Butler; *anemone*, Felder; *connexiva*, Butler; *æsiope*, Men.; *sari*, Horsfield).

Thanks to the scientific investigation of Mr. H. Pryer, it is now demonstrated that this butterfly is found in nearly every country, and that the long list of varieties do not constitute special species, as most of them interbreed without difficulty. It is abundant throughout China and Japan.

Eurema blanda, Boisduval.
*Delias pasithoe, Linn.
*Delias hierte, Hübner.
*Lycaena boetica, Linn.
*Lycaena lysimon, Hübner.

Both of these are common throughout the greater part of the year.

*Neptis aceris, Lep. (*intermedia*, Pryer).

Abundant, and very variable in size.

Vanessa charonia, Drury.
*Vanessa callirhoe, Fabricius.

Quite common, but a very beautiful insect. Feeds on several *Urticaceæ.*

*Vanessa cardui, Linn.

This butterfly has a very wide spread, and comes early in spring and stays throughout the summer. It is quite as abundant as the foregoing.

*Argynnis niphe, Linn.

Not uncommon, but very local.

*Argynnis eurymanthus, Drury.
*Melanitis leda, Linn.
*Mycalesis gotama, Moore.
*Mycalesis perseus, Fabricius.
Mycalesis perseus, var. *visala*, Moore.
*Mycalesis igoleta, Felder.
*Mycalesis medus, Fabricius.
*Mycalesis mineus, Linn.
*Ypthima baldus, Fabricius.
*Ypthima asterope, Klug.
Ypthima philomela, Joh.

The first of these three is very abundant, but varies remarkably in size, markings and colorations. I am inclined to believe that the latter two are one and the same species.

Discophora celinde, Stoll.
*Junonia lemonias, Linn.
*Junonia laomedia, Linn.
*Junonia Wallacei.
*Junonia hierta, Fabricius.
Junonia hierta, var. *cebrene*, Trim.
Junonia orithya, Linn.
*Junonia asterie, Linn.
*Junonia almana, Linn.
*Precis iphita.

***Ergolis ariadne**, Linn.
***Athyma perius**, Linn.
Athyma leucothoe, Linn.
Athyma sulpitia, Cram.
***Athyma kasa**, Moore.
***Euthalia puseda.**
***Lethe Europa**, Fabricius.
***Danais genutia**, Cramer.
***Danais tytia**, Gray.

This and the foregoing insects attain unusual dimensions in the warm climate of Hongkong. The latter is found also in Japan, but is invariably smaller in size.

***Danais limniace**, Cramer.
Danais similis, Linn.
***Danais plexippus**, Linn.
***Catopsilia philippina**, Cramer.
Catopsilia pyranthe, Linn.
***Hebomoia glaucippe**, Linn.
Hebomoia crocale, Cramer.
Ixias pyrene, Linn.
***Miletus chinensis**, Felder.

This pretty member of the *Lycænidæ* is said to be confined to Hongkong, but I have taken it in several places on the mainland.

***Euplœa superbus**, Herbst.
***Euplœa midamus**, Linn.

The latter is much more frequent than the former. It varies remarkably in size; more so, perhaps, than any other butterfly haunting the gardens of Hongkong.

***Hesperia flava**, Murray.

Common throughout China and Japan.

***Pamphila mathias**, Fabr.
Pamphila maro, Fabr.
Plesioneura folus, Cramer.
Hipparchia eumea, Drury.

I have, in the foregoing list, not made any attempt at correct classification. The field, so far as the province of Kwangtung, or indeed southern China, is concerned, is a virgin one. Much remains still to be done, as the greater part of those who collect, or have collected, in Southern China, have neglected to give careful data as to the localities, seasons, etc. By far the most important part of the little work hitherto done is thus untrustworthy or often downright misleading.

The following list of moths includes merely the most important species; from personal observation I believe that more than three hundred species can be identified as coming from Hongkong:—

Charocampa suffusa, Walker.
**Charocampa pallicosta*, Walker.
**Acherontia medusa*, Butler.
Diludia discistriga, Walker.
**Diludia increta*, Walker.
Northia tenuis, Butler.
**Phissama vacillans*, Walker.
Spilarctia subcarnea, Walker.
**Lælia sinensis*, Walker.
Pantana ampla, Walker.
**Acontia bimacula*, Walker.
(Acontia maculosa ?)
**Boarmia repulsaria*, Walker.

**Ophiusa arctotænia.*
**Tropæa artemis*, Butler.

In conclusion, it is necessary to state that the list of butterflies is by no means exhaustive. There are some five or six doubtful species which the writer has thought best not to include; and, besides these, there are one or two others that may, very probably, turn out to be *species novæ.*

March 31.

Mr. George W. Tryon, Jr., in the chair.

Thirty-four persons present.

The following was presented for publication:—

"Remarks on Lanius robustus Baird, based on an examination of the type specimen," by Leonhard Stejneger.

The following were ordered to be printed:—

DESCRIPTION OF A NEW SPECIES OF THE GENUS CYANOCORAX.

BY ALAN F. GENTRY.

Cyanocorax Heilprini, n. sp.

Sp. Char.—Above light brown, with decided purplish shade. Front of head from a line directly back of eye, sides of head and neck, together with the throat, black; frontal plumes bristly and recurved; spot of purplish-blue at base of lower mandible. Crown, occiput and hind-neck lilac or light violet. Breast and abdomen brown, with deeper purplish reflections than on the rest of the body, and becoming lighter towards the vent. Tail concolorous with back above, brownish underneath, and broadly tipped with white; under tail-coverts white. Tibiæ ashy; bill and legs black. Length, 14·25; wing, 6·75; tail, 6·37; tarsus, 2·75; bill, 1·50.

Habitat.—Rio Negro. A single specimen, marked ♂, and part of the T. B Wilson Collection of the Academy of Natural Sciences.

Mr. R. B. Sharpe, in his Catalogue of the Birds of the British Museum, vol. iii, divides the genus into two sections, which are respectively characterized by the presence or absence of white tips to the tail-feathers. While properly coming under the first division by reason of the existence of tips, it differs very markedly from the species therein included, the breast and abdomen being purplish brown and dusky instead of white, and the blue or white spot above, as well as below the eye, being wanting. But in the close resemblance which obtains between the upper and lower surfaces of the body, there is a manifest relationship to the group with uniform tail-feathers.

. The species is dedicated to my friend, Prof. Angelo Heilprin, of Philadelphia, in recognition of his services to science.

REMARKS ON LANIUS ROBUSTUS (Baird), BASED UPON AN EXAMINATION OF THE TYPE SPECIMEN.

BY LEONHARD STEJNEGER.

In April, 1843, there was referred to the Academy, for publication, a paper by Dr. William Gambel, entitled "Descriptions of some New and Rare Birds of the Rocky Mountains and California," where he had been traveling at the instance of Mr. Nuttall. The Committee on Publication, of which Mr. Cassin was a member, recommended it, and consequently it was printed in the Proceedings of that year (vol. i, pp. 259–262).

We make at once the remark, that the Academy at that time had not received specimens, as will appear from the note on page 258. On the contrary, the transfer of Gambel's collection was not made before 1847 (*cf.* Proc. Phila. Acad., iii, p. 346). During that very year several large collections were also received and arranged for exhibition by Cassin and Gambel, viz.: the Rivoli collection, Boucier's collection, Wilson's collection, Cassin's collection of West African birds, altogether nearly 18,500 specimens!

The history of the specimen of *Lanius*, which afterwards became the type of Cassin's *elegans* and Baird's *robustus* cannot (from the catalogues and records of the Academy, as I am kindly informed by Prof. A. Heilprin) be traced further back than 1857, when it was described by Cassin in the Proceedings as *L. elegans.*

It will be remarked, however, that Gambel already, in his paper mentioned above, enumerates *L. elegans* as a bird observed by him in California. But it is evident that he does not refer to any particular specimen, and that the birds referred to *elegans* were nothing but *L. excubitorides.* He says: "This species, of which but a single specimen is known to ornithologists [viz., the type in the British Museum], I found abundant in California . . . . . in the adults the breast is pure white; in the young blended with dark brown, like our common species, except the throat and vent, which are white." In his later, more elaborate paper, published in the same year as his collection was turned over to the Academy, Gambel realizes the fact, and simply calls the species met by him *L. ludovicianus* with which he identifies *excubitorides* (Proc.

Phila. Acad., iii, 1846–47, p. 200). Nor is mention made in this paper of any particular specimen.

In his special report upon the increase of the ornithological collection during 1847, Cassin, while mentioning the incorporations of the collection made by Gambel in California, enumerates *Lanius elegans* as among the species "especially interesting," but no allusion to any specimen is made.

It is not before ten years later that we encounter a description and special notice referable to the specimen in question, when Cassin in his "Notes on the North American species of Archibuteo and Lanius" (Proc. Phila. Acad., ix, 1857,[1] p. 213), gives the characters of *Lanius elegans* Swainson, which evidently are taken from the bird now before me. Regarding the distribution of this species, he says: "This appears to be exclusively a western and northern species, the only specimens of which that we have ever seen are in the Museum of the Philadelphia Academy. Our specimen was brought from California by Dr. Gambel." It will be noted that he speaks of several specimens in the Academy's Museum.

Prof. Baird, in the "Birds of North America," page 327, simultaneously describes the same specimen under the heading of *Collyrio excubitoroides*. He refers to it as "Collected in California by Dr. Gambel," and remarks: "This bird has been referred to *L. elegans* of Swainson, but seems to differ in some appreciable points."

The specimen was figured on plate lxxv.

A more detailed description of the specimen is given by the same author in his "Review of American Birds," page 444 (1866), but he seems to have become doubtful as to the origin of the specimen, since the locality is given as "California?" and in the text he says that it is "labeled as having been collected in California by Dr. Gambel." Though "by no means satisfied that the bird is the true *Lanius elegans* of Swainson," the author introduces it under the heading *Collurio elegans*. It may be remarked that no mention is made of other specimens.

Next we find the specimen mentioned in Cooper's "Ornithology of California," edited by Prof. Baird. On page 140 is

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[1] Published in 1858; the paper was recommended for publication at the meeting, Dec. 29, 1857, *cf.* p. 210.

given a woodcut representing the head and one of the secondaries. Of the locality is said: "*Hab.*—Of original specimen, uncertain, but somewhere in western North America."

In Dr. Coues' "Key" (1872), for the first time is seriously doubted the North American origin of the specimen. He says (page 125): "To this species [*C. ludovicianus*] I must also refer the *C. elegans* of Baird, considering that the single specimen upon which it was based represents an individual peculiarity in the size of the bill. This specimen is supposed to be from California, but some of Dr. Gambel's, to which the same locality is assigned, were certainly procured elsewhere, and it may not be a North American bird at all."

The "History of North American Birds," by Baird, Brewer and Ridgway, contains little additional information, except that the bird here is made the type of the new name *Collurio ludovicianus*, var. *robustus*, since it had been shown by Sharpe and Dresser that the type of *L. elegans* Sw. was referable to some Old World species, erroneously said to have come from the "Fur-countries." The authors also assert that they "have no reason to discredit the alleged locality of the specimen."

Not being able to reconcile the statement of Prof. Baird, that the specimen in question "is very decidedly different from any of the recognized North American species," with the reduction of it to a variety under *ludovicianus*, I, in 1878, named the bird *Lanius bairdi* (Arch. Math. Naturv., iii, p. 330), a synonym which, together with many others, Dr. Gadow has seen fit to entirely ignore in the eighth volume of the "Catalogue of the Birds in the British Museum" (1883).

Finally, we have to mention the position taken by Dr. Coues, who, in his "Birds of the Colorado Valley" (p. 546) "under the circumstances, declines to take further notice of the supposed species in the present work." "The circumstances" alluded to seem to be the doubt as to the correctness of the locality attributed to Gambel's specimen, as expressed already in his "Key." We are compelled, however, to take exception to a statement contained in the sentence commencing his account, though, as will be found later on, we agree with him as to the result. He says: "But Dr. Gambel, in 1843 (Proc. Phila. Acad., 1843, 261), described a shrike, *supposed to be* from 'California,' which he identified with Swainson's bird, and called *L. elegans*." The fact is, however, that the species which Gambel, in 1843,

described *l. c.*, not only was supposed to be, but also really was, from "California," being *excubitorides*, collected there by himself, and the statement should correctly read thus: "But Cassin and Baird, in 1858, described a shrike, *supposed to be* from 'California,'" etc.

The latest account of the bird is found in the eighth volume of the "Catalogue of Birds in the British Museum" (1883), p. 243, by Dr. Gadow, solely based on Baird, Brewer, and Ridgway's work. The name is given as *Lanius robustus*, and the habitat, California, is not questioned.

This finishes the literary history of the specimen, which may be tabulated thus:—

1858. *Lanius elegans* Cassin, Pr. Phila. Acad., ix, 1857, p. 213 (nec Swains., 1831).
1858. *Collyrio excubitoroides* Baird, B. North Am., p. 327 (part).
1858. *Collyrio elegans* Baird, B. North Am., pl. lxxv, fig. 1.
1866. *Collurio elegans* Baird, Rev. Am. B., p. 444; Baird and Cooper, Orn. Californ., i, p. 140 (1870).
1872. *Collurio ludovicianus* Coues, Key, p. 125.
1873. *Collurio ludovicianus* var. *robustus* Baird, Am. Natural., vii, 1873 (p. 608); B., Br. and Ridgw., Hist. N. Am. B., i, p. 420 (1874).
1878. ——— ——— Coues, B. Color. Vall., i. p. 545.
1878. *Lanius bairdi* Stejneger, Archiv Math. Naturv., iii, 1878, pp. 326, 330; *Id.*, *ibid.*, iv, 1879, p. 268.
1880. *Lanius ludovicianus robustus* Ridgw., Pr. U. S. Nat. Mus., 1880, p. 175; *Id.*, Bull. U. S. Nat. Mus., No. 21, p. 20 (1881).
1883. *Lanius robustus* Gadow, Cat. B. Brit. Mus., viii, p. 243.

We shall now examine the specimen itself, which, by the courtesy of the authorities of the Academy, I have before me.

It is mounted and in a state of preservation which, though not very good, still makes it sufficient for all practical purposes. No label is attached to it, but on the underside of the stand is written in Cassin's handwriting:—

Dr. Gambel
Lanius elegans
Sw. Faun. Bor. Am.
p. 122
☞ Observe larger bill
J. C.

No number or reference to a catalogue is found anywhere, nor does the Academy seem to possess any special record of the specimen. The inscription is in ink, except the name, which is written with a lead-pencil.

It will be seen that the locality is not inscribed on the stand, and that now, at least, the specimen is not "labeled as having been collected in California."

The U. S. National Museum possesses a very rich collection of North American Shrikes, and the Old World forms are also tolerably well represented, partly due to the incorporation of my own collection of Shrikes, of which formerly I made a specialty. I have compared the type of *L. robustus* with these, the result being as follows:—

The statement of Professor Baird, that it is "very decidedly different from any of the recognized North American species," is eminently confirmed. The material in the Museum has been doubled many times during the twenty years since he wrote the above, but still the type remains unique in its peculiar characters. I need not repeat here his excellent description, but think it proper to sum up the most diagnostic features of the bird, mainly to counteract any erroneous impression that might arise, caused by the quotation above from Dr. Coues' "Key," in which it is asserted "that the single specimen represents an individual peculiarity in the size of the bill." *Lanius robustus* is not only remarkable for its large bill, but also for its general dark color, total absence of light superciliary stripe, the ashy wash of the lower parts, the gray loral spot, the restriction of the white on the tail-feathers, particularly at the base, and the peculiar distribution of black and white on the secondaries, so well illustrated by the figure in Cooper and Baird's Californian Ornithology quoted above.

Of all the Old World members of the restricted subgenus *Lanius*, the present bird only needs comparison with a few dark-colored species. In many respects it resembles *L. algeriensis* Less., particularly in the shade of the gray on the back, the absence of a white superciliary stripe, the ashy under surface; but the wing speculum is much larger, the secondaries differently colored, and the tail with less white, not to speak of the difference in the size of the bill. In the latter respect our bird agrees rather closely with a specimen of a *Lanius* collected by H. B. Tristram at Gennesareth, March, 9, 1864, but it is darker both above and beneath, and the pattern of secondaries and tail is different. This specimen from Palestine seems referable to the form which Gadow says is "intermediate between *L. fallax* and

L. uncinatus," the latter being a big-billed island form from Socotra, off the coast of Eastern Africa, and, judging from his remarks (Cat. B. Brit. Mus., viii, p. 248) some of the specimens from that region east of the Mediterranean may be even more like the type of *robustus*. The conclusion of my comparison is that the latter is more closely allied to some of the forms inhabiting the regions south and east of the Mediterranean, than to any of the known Nearctic species, but that it is entirely distinct from any other species known.

We shall now shortly review the evidence bearing upon the origin of the type: 1. Gambel himself nowhere directly and particularly refers to the specimen in question; 2. His collection was turned over to the Academy four years after his original paper was published; 3. During the same year the Academy received more than 18,000 specimens, a great many of which were from the Old World; 4. Not before ten years after is any direct allusion made to the specimen by Cassin; 5. No indication of it having been collected in California, can now be found attached to the bird or the stand; 6. We have Dr. Coues' testimony that "some specimens of Dr. Gambel's, to which the same locality (California) is assigned, were certainly procured elsewhere"; 7. So far as the evidence goes, the bird is nearer related to some Old World forms than to those from North America. The sum of all this would indicate that the specimen in all probability is not North American, and enough reasons are given to explain how the mistake may have easily originated. It would not be human, if in receiving and putting on exhibition more than 18,000 specimens in one year some such mistakes did not happen. I therefore think we would be fully justified in excluding *Lanius robustus* from the list of North American birds.

But it should always be borne in mind, that notwithstanding the apparent conclusiveness of the above remarks, the question is not fully solved before we have pointed out where the species really occurs, since there is a bare possibility that some day it may be discovered not far from its alleged habitat in spite of all our arguments. *L. robustus* is very distinct from the other American Shrikes, but not so much so, that its eventual discovery in any part of the Nearctic region would cause a great surprise as far as this point is concerned. The large bill and the dark color suggest some southern island, and explorers of islands off our southwest coast should be on the look-out.

APRIL 7.

The President, Dr. LEIDY, in the chair.

Twenty persons present.

The Primary Conditions of Fossilization.—Mr. CHARLES MORRIS made a communication in answer to the query: "Why are there no fossil forms found in the strata preceding the Cambrian?" In mineral conditions there is little difference between the two sets of strata. Yet the Cambrian contain numerous fossils, while the preceding strata are barren in this respect. This Cambrian life, however, does not come in the succession we might naturally expect, and it may be desirable to consider the succession which actually occurs.

Of Protozoa there is not a trace, if we reject the doubtful Eozoön. Yet vast numbers of Protozoa must have existed, and if there were any calcareous- or siliceous-shelled forms, as at present, they must have left some indication in the rocks. The Metazoa do not begin with the lowest forms, but the different orders make their appearance in very odd conjunction. Thus, at the very beginning, we have a great variety of tribolites, in conjunction with a much smaller variety of annelides and mollusks, while there are very scanty traces of sponges, echinoderms and the lower crustaceans. The most advanced form of these animals, the trilobite, greatly outnumbers all its contemporaries.

At a considerably later date two widely separated forms come together into existence. The low order of Hydrozoa makes its first appearance as the Graptolite, and at a closely related date appear Cephalopods, the highest order of Mollusks. The Silurian era opens with an abundance of Graptolites and a considerable increase of Cephalopods. It is much later ere any clear trace of Vertebrates appears, and this in what is certainly not their lowest form.

The appearance of land animals presents a somewhat similar phenomenon. No land Vertebrates appear below the Carboniferous rocks, yet it is now known that insects existed well down in the Silurian, proving that the conditions necessary for land life had very long prevailed ere Vertebrates left the sea for the land.

It is impossible to believe that these fossils represent truly either the beginning or the actual succession of life upon the earth. Such an idea would be utterly inconsistent with the development theory, and even under the creation hypothesis it is incredible that life could have begun with such a confused mixture of high and low. No one, for instance, can accept what the rocks seem to teach, that advanced forms of Mollusks and Crustaceans came into existence before the Cœlenterata. It may be taken for

granted that we have but fragments of the primeval life, and these fragments associated in a manner that cannot indicate the actual life conditions.

These earliest animals are mainly burrowing, crawling, or stationary forms. There is very little indication of the abundance of swimming life which now crowds the ocean and must have then done so. We find only minute swimmers, such as Pteropods and Phyllopods, while if the Trilobites were able to swim it must have been but a sluggish movement. There is no indication of the existence of rapid and powerful swimmers.

Yet there are several reasons for believing that swimming animals existed in abundance. The rapid swimmer has an advantage in food-getting and in escape from danger over the slow-moving surface animals. Natural selection, therefore, must have tended to produce swimming forms.

The facts of embryology yield evidence to the same effect. Nearly or quite all ocean animals begin life as swimmers. The stationary forms become fixed only after their larval period is passed. This fact indicates that at some early period the ancestors of our present fixed forms were free swimmers.

But a stronger proof of this is found in the condition of the animals whose fossil forms we possess. They are all covered with protective armor. It is, indeed, to the preservation of this armor that we owe our knowledge of their existence. We find no weapons of offense. Everything is defensive. Even the trilobite, which had nothing to fear from the other known forms, was clothed in a strong coat of mail, and had acquired the habit of rolling himself into an impenetrable ball. There can be no question that he had foes, stronger than himself, against whom he found defense only in his chitinous armor. Yet of these predatory foes we know nothing.

All other preserved forms tell the same story. We would know nothing of them but for their hard parts, and these hard parts are all protective. The soft-bodied annelid saved itself by burrowing in the mud. The mollusk clothed itself in a firm limy covering. Of the remaining forms each wore some kind of defensive armor. Many of them doubtless needed defense against the trilobites, but the foes of the trilobite are missing.

If we ascend higher in the rocks, the same tale is told. The Hydrozoa, which had probably swum the earlier seas in forms allied to our soft-bodied Medusæ, become stationary and protected as Graptolites. And simultaneously the powerful Cephalopods make their appearance as surface forms, clothed in a heavy and cumbrous defensive armor. If they formerly had mastery of the seas, as we may conjecture, they had been driven from it by some more powerful and rapid foe.

In fact all the preserved forms may be looked upon as to some extent degenerated types of life. They very probably represent

earlier free-moving forms, which have been driven to wear heavy armor for protection from stronger foes, and have been forced by the weight and the character of this armor to take up a life on the ocean bottom, either as stationary, crawling, or sluggishly swimming forms.

Where are the foes who have forced these forms of life into degenerated conditions? They are indicated in the rocks by no hard parts, either offensive or defensive. They probably needed no protective armor, they had no internal hard skeletons, and the only trace of early offensive weapons are found in the dubious Conodonts, of the lower Silurian strata. Not until undoubted fish teeth appear do we find unquestionable weapons of offense. And there is no indication of active predatory swimmers until we find the earliest fish remains. We may conceive that fishes had so increased as to sweep the seas of any overabundance of food forms, and had begun to actively prey upon each other. Then they developed the protective armor to which they had previously driven their prey. And this armor increased in thickness and strength until the remarkable bony plates of the Devonian fishes were produced. But in all probability several successive types of life obtained mastership of the ocean, each superior form driving all earlier forms to seek protection. Of these the fish was the last and most powerful, and it cleared the open seas of all competitors.

Only from some such cause as this can we understand the sudden appearance of the Cambrian Orthoceratites, with their bulky and clumsy shells, which certainly would never have been developed except through pressure of sheer necessity. This armor must have greatly diminished the motor powers of the cephalopod; it was solely protective in character, and it is impossible to impute it to any cause save that of defense from a powerful predacious foe. All the early lords of the ocean had successively to clothe themselves in strong armor, or to vanish from existence as more powerful forms appeared.

There are strong indications, therefore, that in addition to the armored forms preserved in the rocks, there was abundance of naked forms of life, mainly swimmers, and pursuing a predatory mode of life. If we pass backward through the succession of fossil forms, it is to find the armored types decreasing in numbers and variety. We seem to gradually approach a period in which the naked swimming forms were greatly in excess. This may have been preceded by a period in which there were no armored forms. In such a case, though life may have been as abundant as now, it could not have been fossilized. Such may possibly have been the pre-Cambrian life condition.

There could have been no era of life, indeed, in which predatory forms did not exist. But there may have been a long period during which animals were incapable of secreting armor. The

organic functions are certainly not all of primitive origin. Many of them may have been the product of ages of slow development. Such may have been the case with the development of glands suitable for the secretion of chitin, carbonate of lime, and the other protective substances. We know that it was at a late date in the history of life when animals first began to secrete an internal hard skeleton. The need of protection undoubtedly caused a more rapid evolution of the power to secrete an external hard covering, and yet life may have long prevailed before this adaptation was gained. The mantle of the bivalve mollusks, for instance, with its glands for the secretion of a limy shell, cannot have been a primitive feature of molluscan life. So the chitin-forming glands of the crustaceans may have been a late product of evolution. It is possible that, in the early days of life, all the mineral ingredients of food were directly excreted. It is equally possible that the power of transforming food elements into hard substances did not exist. The development of dermal glands, necessary to the secretion of external skeletons, teeth, etc., must have occupied a considerable time, and its completion may have taken place but shortly before the opening of the Cambrian period.

If such was the case, the preceding life must have been of a low order, and of small dimensions. Animals might have grown to considerable size with cartilaginous skeletons, but scarcely without teeth or other hard weapons of offense, of which no trace remains. It may be that the earlier forms of life were in great part swimming animals, that they waged constant war upon each other, and that in time, through the action of natural selection, the power of secreting defensive armor was evolved. As this armor grew denser and heavier the swimming powers became abridged, and the armored animals were successively carried to the bottom, and forced into slow-moving or stationary habits of life.

In corroboration of this idea is the fact that the power of secreting an internal skeleton appeared only at a much later date. It has never been developed in the Invertebrates, except in late cephalopods, and in all these animals the external armor has necessarily been utilized for muscular attachment. The superiority of the vertebrates is largely due to the fact that their muscular attachment has always been internal, a method which gives much greater flexibility and power of movement. Yet for a long period after the appearance of vertebrate life the basis of muscular attachment was merely a rod of cartilage. Even the great Devonian fishes, with their dense epidermal plates, were destitute of internal bone, except that in a few cases they possessed ossified vertebral arches. The next evidence of power to secrete internal bone is found in certain Carboniferous Ganoids, which possessed a mere ring of bone in the external portion of their vertebræ. It cannot reasonably be argued that bony skeletons

would have been of no use to these ancient swimmers. The possession of bony skeletons by all the Teleostei shows that this adaptation is a valuable one. Modern Sharks and Ganoids, while often cartilaginous, frequently possess completely ossified vertebræ. Thus we have reason to believe that the absence of internal bone in the most ancient fishes came from the fact that the conditions for the secretion of such bone had not yet been developed.

This leads to one further conclusion. Though a cartilaginous basis of muscular attachment might suffice for large swimming animals, it would not answer for large forms of terrestrial life. In these a greater rigidity was necessary. Therefore land vertebrates of large size could not appear until after the power of forming a bony skeleton had been attained. And it is significant that shortly after the appearance of bone in fish skeletons the Batrachians make their appearance in the rocks. We know that the land had been adapted for animal life for long ages before, and peopled by insects and scorpions, and possibly by forms of life of which we have no comprehension. It is very probable that fishes had long used the land as a temporary place of residence and feeding-ground. This we may safely infer from the existence of fossil Dipnoi, with their powers of breathing air or water at will. Yet it was impossible that large land vertebrates could appear until the bone-making power was fully developed. *Archægosaurus* one of the earliest air-breathers, possessed but a ring of bone in its vertebræ, like the Carboniferous Ganoids. But in all the remaining Carboniferous Batrachians a fully ossified skeleton appears, and this has been ever since an absolute requisite of all land vertebral life, and of all ocean vertebrates except a few survivals of the antique types.

Thus we reach the general conclusions that fossilization of animal forms was not possible until, after a long period of evolution, the power of secreting hard external coverings was gained; and that the existence of large land vertebrates was not possible until, after a still longer period of evolution, the power of secreting internal bony skeletons was developed. If these conclusions be well founded, many of the conditions of early life must remain forever unknown to us, and we cannot hope to recover more than a fragment of the antique fauna.

APRIL 14.

The President, Dr. LEIDY, in the chair.

Thirty-one persons present.

A paper entitled "Notes on Mesozoic Cockroaches," by Samuel H. Scudder, was presented for publication.

Hibernation and Winter Habits of Spiders.—The Rev. Dr. McCook remarked that the effect of a low temperature upon spiders was observed in the cases of several young specimens of *Theridion tepedariorum.* They hung on a few short lines to the plastered wall of a brick out-building, the plaster being laid directly on the brick, forming a very cold surface. The spiders were protected from the wind and snow, but wholly exposed to the frost. January 14 (1885), with thermometer ranging from 20° to 25° above zero (Fahrenheit), the spiders were hanging motionless. When touched by the tip of a pencil they dropped down in the usual manner of their kind, holding on by the outspun threads which reached a length of over one foot. They ascended to their perch afterward, and crawled over the roof a little ways.

At a temperature of 18·6° they again were able to drop from the perch. January 19, with thermometer ranging from 17·5° to 20°, they seemed less active—one, when touched, dropping about one inch, another six inches. Four hours thereafter they were suspended in the same position. As the natural habit of the creature is to ascend in a moment or two after disturbance, this shows that the frost had somewhat affected the normal energy. But one of them, being gently lifted on the finger, moved its legs and very slowly began to ascend. Five hours thereafter it was at its perch against the roof. These spiders, at this temperature, with some variations (January 21), moved their position, one passing along the angle of the roof, a distance of four feet. This change of site was probably caused by the annoyance which the experiments produced.

February 11, the thermometer stood at zero at the City Signal Service Office; in West Philadelphia, where his observations were made, the temperature was lower. On the 12th, the Signal Service reported 1° above zero; at his house it was below zero. On this day he removed from its position one of the specimens, a young female about two-thirds grown, and placed it in his library where the temperature was summer heat. She was laid upon the table in the sun. The legs were drawn up around the cephalothorax in the usual "hunched" way when torpid or feigning death. There was a slight and regular pulsation of the feet. In less than ten minutes, upon being touched, she stretched forth her legs and began to move slowly over the paper upon which she had been placed. When touched, her motion was much accelerated, and she began vigorously to perambulate her bounds, anchored to and pulling out after her the usual drag-line. When lifted up on the tip of a pencil she spun out a long thread, to the end of which she hung in the little basket-like structure of silken cords which he had elsewhere described. Indeed, her action was in every respect normal, and showed a remarkably sudden and complete revival of activity after so long an exposure to such extreme cold.

February 26, a younger specimen, about one-third grown, hanging in a crevice in the site above described, when touched and lightly pressed down, slowly moved its legs and began to struggle back to its perch. The thermometer ranged from 20° to 25°; on the day before the range was from 21° at 7 A. M., to 28° at 11 A. M.

During the six weeks over which these observations extended, the temperature was unusually low for this vicinity; for a great part of the time, the thermometer stood below freezing point, and several times reached zero. The month of March following was unusually severe, the thermometer frequently reaching winter temperature. On the first of April, however, the above-named spiders, and others of a younger brood, were in their webs hale and active, drawn out by the first soft days of spring. It would seem, therefore, that the hibernation of spiders (of this species, at least), is not accompanied with a great degree of torpidity; that they preserve their activity and spinning habit while exposed to cold ranging from freezing point to zero (Fahrenheit); that after long and severe exposure, the recovery of complete activity when brought into a warm temperature is very rapid, almost immediate; and that on the return of spring, even after a prolonged and severe winter, they at once resume the habits of their kind.

In all the above specimens the abdomens were full, indicating perfect health. Other spiders hung upon their webs with shriveled abdomens, quite dead, among them one of his specimens, a male, who died during the course of the observations. A *Pholcus phalangioides* hung thus dried up, holding with a death-grip to her web by the two fore-pairs of legs which supported the cephalothorax in a position parallel to the plane of the horizon, while the long abdomen hung down at right-angles thereto, and the third and fourth pairs of legs were drooped downward and backward. He could not determine that these and other spiders perished by the cold. The living individuals were all characterized by the plump abdomen, as though there had been little or no absorption of tissues for nourishment of life. There appeared to be no growth during hibernation.

The same facts hold good as to the winter habits of Orb-weavers. The young survive the winter in the admirably arranged cocoons provided by maternal instinct. But early in the spring many adults of both sexes are found nearly full-grown, who have also safely weathered the cold months. He had, at various times in midwinter, collected examples of *Epeira strix*, and had found the species adult in spring. Specimens of Strix may be frequently taken during the winter months from rolled leaves, within which they have weathered our hard frosts. These rolled leaves also serve for nests during summer. Dr. Geo. Marx had informed him that, on the capacious Government grounds in

Washington city, he often sees such curled leaves suspended conspicuously amid the verdureless branches, and had learned to recognize them easily as the winter-quarters of this species. It of course follows that, either from purpose or by the accidental unwrapping of the threads during continual journeys back and forth trailing her drag-line behind her, the spider prevents the leaf from falling.

A vast colony of *Epeira vulgaris* inhabits the boat-houses grouped around the inlet wharf at Atlantic City. Dr. McCook stated that he had once visited this colony, May 22, 1882. The season had been a remarkably backward one, cold, and very rainy. The trees on the island had not yet leaved; insect life had scarcely appeared; in short the season had advanced little further than the first of May in ordinary years. The inlet colony, however, had already appeared in large numbers, and had swung their orbs between the timbers of the houses and the piles which supported them. These were of various sizes, full-grown, half-grown, and young several weeks out of the cocoons. All the cocoons—which were thickly laid along the angles of the joists and cornices—were empty. The number of young spiders was, however, remarkably small, a fact which he could account for only on the supposition that in the absence of the usual insect food supply, the adults had been driven to prey upon the young and the young upon each other to an unusual degree. Many of the spiders were hanging in the centre of their round snares. Others—the greater part, indeed—were sheltered within a thick tubular or arched screen, open at both ends, which was bent in the angles of the woodwork, or beneath an irregular rectangular silken patch stretched across a corner.

Many others were burrowed behind cocoons, quite covered up by the thick flossy fibre of which these are composed. In this condition they had undoubtedly spent the winter. He had found examples of *E. strix* blanketed in precisely the same way during the winter months. Unfortunately he had never been able to make a mid-winter journey to this favorite spider-haunt, in order to see the araneads in extreme hibernation; but he asked some of the young boatmen what the spiders did in winter-time. "They crawl into their bags," one answered, referring to the screens and tubes above described, "and stay there. They came out about a month ago (the last of April), and then 'shed.' A couple of weeks ago the sides of the houses were all covered with these 'sheds'"—by which, of course, the young man meant their moults.

The following was ordered to be printed:—

NOTES ON MESOZOIC COCKROACHES.

BY SAMUEL H. SCUDDER.

I. *Pterinoblattina, a remarkable type of Palæoblattariæ.*

Among the many fossil cockroaches figured by Westwood thirty years ago, was one which Giebel afterwards named *Blatta pluma*, on account of the resemblance of its neuration to the barbs of a feather, where the shaft is on one side. Several species are now known, and on account of this curious arrangement of the veins, the generic name,

PTERINOBLATTINA (πτέρινος)

is proposed. The wings were very broad, expanding considerably beyond the base, broadest beyond the middle, and filled with an abundance of branching veins. The mediastinal, scapular, and externomedian veins ran close together, side by side, in a perfectly straight course (the shaft of the feather), from near the middle of the base of the wing toward and nearly to a point on the costal margin a little within the apex of the wing, and the superior mediastinal and inferior externomedian branches, crowded closely together, parted from this apparently common stem at nearly similar angles on either side of it. The complete independence of the mediastinal, scapular, and externomedian veins shows that the genus falls in the Palæoblattariæ. The species are all small.

Pterinoblattina pluma.

Blatta pluma Gieb., Ins. der Vorw., 322. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, pl. 15, fig, 14†.

The specimen, the original of which I have had the privilege of studying, by the favor of my kind friend Rev. P. B. Brodie, is rather imperfect, and a little deceptive from the fact that just that portion of the tip is missing which contains the scapular branches; it is probable, however, from the longitudinal character of the apical externomedian offshoots that the species more closely resembles *P. chrysea* than *P. intermixta*. All the mediastinal branches are simple, parallel, equidistant, almost straight, closely crowded, and part from the main stem at an angle of about 45°. The externomedian branches, the only others preserved, part at a less angle, gradually become quite horizontal apically, are nearly

as close at base as the scapular branches, and as most of them fork and even re-fork, though with entire irregularity, become excessively crowded toward the margin. The length of the fragment is 9 mm., its breadth 5 mm. Probably the wing was 12 mm. long, and 5·5 mm. broad.

It was found in the Corbula or Pecten beds of the Dorset Purbecks of England.

Pterinoblattina penna, sp. nov.

The single specimen of this species at hand is preserved in much the same manner as the last, but shows a fragment of the internomedian region. The three principal veins approach each other very gradually so as to give them the appearance of a tapering rod. The mediastinal branches part from the stem at nearly a right-angle near the base of the wing, gradually increasing in obliquity distally, until they form an angle of 45° with it; they are slightly curved, the concavity outward, very closely crowded, and about every third one forked near the middle, but with no regularity. The scapular branches are not preserved, but as in *P. pluma*, and for the same reason, they probably resemble *P. chrysea* rather than *P. intermixta*. The externomedian branches are very closely crowded, generally straight, part from the stem at an angle of 45° next the base, and become almost wholly longitudinal at the apex; they fork about as frequently as, and more irregularly than, the mediastinal branches. The internomedian area extends far out on the wing, and its branches (what few can be seen) resemble those of the preceding area, and at its extremity are parallel to them. Length of fragment, 13 mm.; width, 9 mm. Probable length of wing, 15 mm.; probable width, 9 mm.

Described from a specimen from the English Purbecks sent me for examination by Rev. P. B. Brodie.

It is not impossible that the fragment of a larger wing figured by Westwood (Quart. Journ. Geol. Soc. Lond., 1854, pl. 17, fig. 7), from the Lower Purbecks of Durdlestone Bay may be a species very close to this.

Pterinoblattina chrysea.

Blattina chrysea E. Geinitz, Zeitschr. Deutsch. Geol. Gesellsch., 1880, 520, pl. 22, fig. 2.

In this case we have a more perfect wing, the tip being almost completely preserved. The mediastinal vein terminates before

the middle of the outer half of the costal border, and is furnished with simple, straight, oblique branches, not so numerous as in the other species, to judge by the figure, though they are spoken of by Geinitz as "very numerous and closely crowded." Just before the scapular reaches the tip of the mediastinal, it turns parallel to the costal margin, runs to the upper tip of the wing, and emits branches similar to those of the mediastinal, but of course of equal length. All the externomedian branches run almost longitudinally, are straight, sometimes forked, and appear from the figure to be less crowded than the mediastinal branches, though they are compared by Geinitz to the barbs of a feather. The internomedian runs to just beyond the broadest part of the wing, being thus longer than the mediastinal, and sends less crowded, gently curved, usually forked, rather short branches to the border. The few anal branches curve and strike the inner margin. Length, 5 mm.; breadth about 2·25 mm.

From the Lias of Dobbertin, Germany. The description is drawn up from the data given by Geinitz.

Pterinoblattina intermixta, sp. nov.

A nearly complete wing of this species has almost the same shape as *P. chrysea*, but the upper part of the apex is more produced. The mediastinal vein terminates before the middle of the outer half of the wing, and the area narrows more gradually than in any of the others; its branches are gently curved, and often forked, but not excessively crowded. Just before reaching the tip of the mediastinal, the scapular vein suddenly bends toward the apex, running subparallel to, but away from the costal margin, terminating at the tip and emitting a crowd of curved and forked branches. The closely crowded externomedian branches part at an angle of 45° with the stem, are straight, and fork only just before the tip, forming a tolerably regular belt of crowded veinlets along the margin. The basal branches, however, are interfered with and affected by the internomedian vein, which is nearly straight, at first running plump against the externomedian branches, curves then downward parallel to these and terminates a little before the mediastinal; it is furnished abundantly with branches curving like its extremity and branching next the border like the externomedian branches, but where it abuts against these latter they simulate the appearance of the internomedian branches so as to appear as if a part of the internomedian area, and thus

give the latter the appearance of extending out beyond the broadest part of the wing. The anal appears to be insignificant, reaching less than a third the distance from the base and resembling a narrower and smaller internomedian area. Length of fragment, 10·5 mm., probable length of wing 12 mm.

Received from Rev. P. B. Brodie, as coming from the Upper Lias of Alderton, Gloucestershire, England.

Pterinoblattina hospes.

Ricania hospes Germ., Acta Acad. Leop. Carol., xix, 220–21, Pl. 23, fig. 18.

Germar took this for one of the Fulgorina, in the neighborhood of *Ricania* and *Pœciloptera*. It is pretty plain, however, that it belongs here, though the figure given by Germar is not sufficiently clear to enable one to formulate any characteristics. Assmann thought it a Neuropteron, falling in the neighborhood of *Drepanopteryx*.

It comes from the Oolite of Solenhofen.

Pterinoblattina gigas.

Ricania gigas Weyenb., Arch. Mus. Teyl., ii, 270–71, pl. 35, fig. 23.

Following Germar, Weyenbergh placed this enormous species in *Ricania*, but it as evidently falls here and bears a close general resemblance, excepting in size, to *P. penna* of the Purbecks. *Ricania fulgens* Gieb. (Brodie, Pl. 4, fig. 12), from the Vale of Wardour, has nothing to do with *Pterinoblattina*.

This gigantic form also come from the Oolite of Solenhofen.

II. *Triassic Blattariæ from Colorado.*

In a recent paper I described some of the Triassic Palæoblattariæ, which I mentioned as interesting on account of their special relation to the Blattariæ of the same formation. Brief diagnoses of these latter forms will therefore have some interest, and I mention them in the order of their relation to the Palæoblattariæ.

NEORTHROBLATTINA (νέος, ὄρθρος), gen. nov.

In this genus the wings are about two and a half times longer than broad, with fairly well rounded apices, the mediastinal and scapular veins amalgamated into a single vein, which extends nearly to the tip and in the middle of the wing occupies nearly one-half its width. The internomedian vein is of varying impor-

tance, and in the large anal area the veinlets terminate on the margin; the anal furrow is strongly arcuate, and deeply impressed.

Neorthroblattina albolineata, sp. nov.

The single wing has lost the tip, but all the essential features are preserved, excepting the form of the tip. The wing is very dark colored, and the veins appear as very pale lines upon it. The costal margin is gently and equably arched, while the inner margin is perfectly straight. The externomedian vein is little developed, first forking and then not widely in the middle of the wing, its fuller development being prevented by the ample and unrestricted development of the internomedian vein, which runs in a full rounded course nearly to the tip of the wing. The anal area is interesting because the veins of the upper half run close to, but do not impinge upon the anal furrow, curving downward just before reaching it, and either running into the next vein below and terminating there, or continuing parallel to the furrow and terminating on the inner border. Length of fragment, 7 mm.; probable length of wing, 9 mm.; breadth of wing, 3·5 mm.

Triassic beds near Fairplay, Colorado.

Neorthroblattina Lakesii, sp. nov.

Several specimens of this species were found. The costal margin is arched as in the last species, and the inner margin has an almost equal opposite curvature. The externomedian vein has a very sinuous course, and forks before the middle of the wing with abundant neuration, occupying on the margin the entire tip of the wing, and almost the outer half of the lower margin, while the internomedian is reduced to an arching vein, extending but little beyond the anal furrow, and with only two or three branches; the anal veins are all parallel to the anal furrow and simple. Length of wing, 9 mm.; breadth, 3·5 mm.

Triassic beds near Fairplay, Colorado. This species is named after Prof. Arthur Lakes, of the School of Mines, in Golden, Colorado, who first made known these beds; this species being one of the first discovered by him.

Neorthroblattina rotundata, sp. nov.

The costal margin in this species is very strongly arched, while the inner margin is straight, giving a very different aspect to the wing. It closely resembles the preceding species in the mediastino-

scapular, and anal areas, and also in the peculiarities of the externomedian vein, excepting that the latter does not encroach to so large a degree upon the internomedian, the terminal offshoot of which creeps along the border so as to limit the marginal extent of the externomedian area almost as much below as above, although the branching of the externomedian vein is scarcely lessened. Length of wing, 8·5 mm.; breadth, 3·3 mm.

Triassic beds near Fairplay, Colorado.

Neorthroblattina attenuata, sp. nov.

This species departs from the typical forms in its slenderness and pointed apex, but it agrees so fairly in general structure that it would best be placed here. The costal margin is not regularly arched, being flattened mesially, while the whole wing tapers beyond the basal third; the inner margin is also arcuate, and the tip bluntly pointed. The mediastino-scapular vein terminates considerably before the apex, and the oppositely arcuate internomedian reaches almost as far out, the branches of both nearly always simple. The anal veins are only slightly irregular. Length of wing, 15 mm.; breadth, 4 mm.

Triassic beds near Fairplay, Colorado.

SCUTINOBLATTINA (σκύτινος), gen. nov.

In this genus, composed of small species, the front wings are decidedly more coriaceous than the hind wings, so that the neuration is often more or less obscured by it. The wing itself is convex, as in the modern *Phoraspis*, and subtriangular in form, its greatest width being near the base, while the tip is bluntly pointed. The mediastinal and scapular veins are again blended into one, which, instead of having a sinuous course, is nearly or quite straight, and terminates below the apex of the wing, while the externomedian vein follows closely parallel to it, and the oblique veins of this and the internomedian veins follow each other so as to make it difficult to tell where the line of demarkation may lie. The anal veins sometimes fall on the margin and sometimes on the anal furrow.

Scutinoblattina Brongniarti, sp. nov.

In this interesting species the wings are very strongly convex at the base, and the whole surface is flecked with dark spots. The branches part from the main veins at a similar angle on either

side of the middle of the wing. The anal area extends nearly to the middle of the wing, where it is marked by a considerable emargination, and its veins are frequent, oblique, mostly simple, and terminate on the margin. Length of wing, 7 mm.; breadth, 3 mm.

Triassic beds near Fairplay, Colorado. Named after Mr. Chas. Brongniart, of Paris, well known for his remarkable discoveries among the older fossil insects.

Scutinoblattina intermedia, sp. nov.

This species resembles the last, but is not marked by any dots, and the anal area, while shorter, shows no emargination of the border at its extremity; the anal veins are very close, parallel to the inner margin, and terminate not on the margin, but on the anal furrow. It further differs in that the externomedian branches are considerably more longitudinal than those terminating on the costal margin. Length of wing, 7 mm.; breadth, 2·75 mm.

Triassic beds near Fairplay, Colorado.

Scutinoblattina recta, sp. nov.

This species, the smallest and most abundant of all in the Triassic rocks, is rather slenderer than the others, and has the surface finely reticulated. The mediastino-scapular and externomedian veins run side by side in perfectly straight lines from the middle of the base to the middle of the tip, the branches, very few in number, parting similarly on the two sides. The costal is more arched than the inner margin, and where they can be made out, the one or two anal veins seem to run to the margin, but all the veins on the wing are exceedingly obscure. Length of wing, 6·3 mm.; breadth, 2·4 mm.

Triassic beds near Fairplay, Colorado.

III. *On the Genera hitherto proposed for Mesozoic Blattariæ.*

Brodie, in 1845, published figures of a considerable number of mesozoic cockroaches, but named only one, which he referred to the genus *Blatta*. In 1852 Heer figured and named another under the equally broad generic name *Blattina*. Westwood, in publishing in 1854 a considerable addition to our knowledge of the cockroaches of the English mesozoic rocks, separated four somewhat peculiar forms under the generic term *Blattidium*; the rest were

unnamed. Giebel two years later named a considerable proportion of Brodie's and Westwood's species; while placing a considerable number under *Blatta* and *Blattina*, he divided the rest under three new genera, *Rithma*, *Elisama* and *Nethania*, the last including the only one of Westwood's species of *Blattidium* which was noticed. On the other hand, Heer, in 1864, divided all the mesozoic species between *Blattina* and *Blattidium*, placing in the latter all of Westwood's species, together with all those referred to new genera by Giebel. Finally, a few years ago E. Geinitz proposed for a triassic species described by him, and one previously published by Heer, the new generic term *Mesoblattina*.

There is no question that the forms described by Westwood, after eliminating the one separated by Giebel, under the name of *Nethania*, form a very distinct group; but none of the species since added to it belong here, so that

BLATTIDIUM

should stand much as first limited (though not described) by Westwood. Probably, however, it should be still further restricted by the elimination of *B. Achelous* Westwood. The wings are exceedingly long and slender, particularly in *B. Symyrus* Westw.—which may be taken as the type—with nearly or quite parallel sides. The mediastinal vein terminates not far from the middle of the wing, and sends out a multitude of crowded offshoots to the margin. The scapular vein unites in the basal third of the wing with the externomedian, and throws off rather distant oblique veins, first to the mediastinal, and afterwards to the border. The externomedian and internomedian veins have together several more or less forked, very longitudinal branches, all of which appear to terminate on the apical margin, while the main anal vein, longitudinally oblique, extends nearly as far as the mediastinal, and the outer half of the inner margin of the wing seems to have no veins falling upon it; the veins of the anal area run obliquely from the margin upward and outward to the main anal vein.

As to the genera of Giebel, six species are placed by him in *Rithma*, two in *Elisama* and one in *Nethania*. The species of *Nethania* is rather too uncertainly figured to determine by the illustration alone where it belongs. The two species of

ELISAMA

figured by Brodie certainly belong together, and seem to constitute a natural genus. By the kindness of Rev. Mr. Brodie, I have seen the original of his pl. v, fig. 1 (*Elisama Kneri* of Giebel) and another specimen which seems to belong to *E. minor*, so that I can more fully characterize this genus. The mediastinal and scapular veins appear here to constitute one vein, and to occupy almost the entire upper half of the wing. The externomedian and internomedian veins fill the lower half between them with parallel veins, which at their origin curve at once strongly downward, and then run longitudinally to the apical margin, leaving only the meagrest possible space to the anal area, which is indeed broken off from the two specimens I have seen, and does not appear in the figures published by Brodie. In addition, in both the species, there is an abundant, but imperfect, cross-venation at the base of the externomedian and internomedian areas, and on the latter a large discolored spot, which may of course be confined to these two species only.

RITHMA

contains more incongruous material. I have myself recognized in the English species I have examined autoptically only one of the species referred to it, named *R. Murchisoni* by Giebel, and this is certainly to be referred to *Mesoblattina* Geinitz. *R. ramificata* is quite too imperfect to be considered until better specimens occur. It is probable that *R. antiqua* should be separated from the others, and the same may be true of *R. Westwoodi*. This leaves two species, *R. purbeccensis* and *R. Morrisi*, which agree well together, and represent a group which seems to have flourished in mesozoic times, as I have seen a number of species from the English Lias belonging with them, and *Blattina formosa* Heer from Schambelen, and *Blattina liasina* Gieb., figured by Brodie, also belong here. These wings are rounded wedge-shaped, with the amalgamated mediastinal and scapular area so large as to occupy about half of the wing, the vein running in a slightly sinuous course to, or even below, the tip. The anal area is generally pretty large, convex, and filled with parallel veins, which terminate on the margin. The space between is divided about equally between the externomedian and internomedian veins, which generally take a somewhat sinuous

course, and fork with tolerable abundance, filling the space with graceful lines, spreading like (sinuous) rays of a fan. The genus is closely related to *Neorthroblattina* of the American Trias, but differs from it in the much greater area covered by the amalgamated mediastinal and scapular veins.

The following described species may be referred to it:—

Rithma purbeccensis Gieb., Faun. d. Vorw., iii, 319. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 18, fig. 32. Lower Purbecks, Durdlestone Bay, England.

Rithma Morrisi Gieb., Faun. d. Vorw., iii, 319. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 18, fig. 34. Lower Purbecks, Durdlestone Bay, England.

Rithma formosa.

Blattina formosa Heer, Lias Ins. Aarg., 15, Pl. II, figs. 41, 42; Heer, Urw. Schweiz, Pl. 7, figs. 1, 1 *b*,; Lias, Schambelen, Switzerland.

Rithma liasina.

Blattina liasina Gieb., Faun. d. Vorw., iii, 317. Figured by Brodie, Foss. Ins. Engl., Pl. 8, fig. 12; Lower Lias of Wainlode, Strensham, England.

MESOBLATTINA,

proposed by E. Geinitz, as stated, for two Liassic species of continental Europe, is a most prolific type, a considerable number of English mesozoic forms falling here, and among others, as remarked above, those figured by Westwood and described by Giebel under the names of *Rithma Murchisoni* and *R. antiqua*. The former of these, as well as a considerable number of new species have been sent to me by Mr. Brodie. In this genus the basal sweep of the externomedian and internomedian veins is very noticeable, following as they do the curve of the anal furrow before branching to fill the lower half of the wing. In this respect they remind one strongly of Elisama, but the wings are much slenderer than there, and what is of more importance the anal area is of the normal size, while next the humeral angle is seen a flat unveined field, so frequent in modern cockroaches. To this belong among others the following species:—

Mesoblattina protypa Gein., Zeitschr. Deutsch. Geol. Gesellsch., 1880, 519–20, Pl. 22, fig. 1. Lias of Dobbertin, Germany.

Mesoblattina angustata Gein., *ib.*, 519 20.

Blattina angustata Heer, Viert. naturf. Gesell. Zurich, ix, 288, 299–300, Pl. fig. 6. Lias of Schambelen, Switzerland.

Mesoblatina dobbertinensis Gein., Zeitschr. Deutsch. Geol. Gesellsch., 1884, 570, Pl. 13, fig. 1. Lias of Dobbertin, England.

Mesoblattina Murchisoni.

Rithma Murchisoni Gieb., Ins. d. Vorw., 319. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 18, fig. 43. Lower Purbecks of Durdlestone Bay, England.

Mesoblattina antiqua.

Rithma antiqua Gieb., Ins. d. Vorw., 319. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 17, fig. 10. Lower Purbecks of Durdlestone Bay, England.

Mesoblattina elongata.

Blatta elongata Gieb., Ins. d. Vorw., 322. Figured by Westw., Quart. Journ. Geol. Soc. Lond., x, Pl. 15, fig. 23. Middle Purbecks of Durdlestone Bay, England.

April 21.

Mr. Thomas Meehan, Vice-President, in the chair.

Twenty-seven persons present.

Persistence in Variations Suddenly Introduced.—Mr. Thomas Meehan remarked that some public notice had been given to his observations on *Cypripedium insigne* (see page 30 of the Proceedings, 1885), and hence correspondents had written to him of similar behavior in this plant. A correspondent at Lee, Mass., had plants that had subspicate flowers last year; and one from Sharon, Western Pennsylvania, wrote that Mr. O'Brien of that place had a plant that produced such flowers four years ago, and the same plant had produced them annually ever since. There could be very little of what is understood by the term environment to so affect one plant that it should change in this manner any more than other plants growing under the same conditions of environment; and when we found the same species producing identical variations in localities two or three hundred miles apart, the application of the term environment had absolutely no meaning at all. We must still continue to search for some power that gave law to the production of variation—in other words, we had yet no comprehensible theory of the origin of species. That new species owed allegiance to the power of variation must be admitted, for these variations were species. The subspicate inflorescence and accompanying changes in the forms of the flower, were specific characters. We had no right to undervalue the characters because we happened to know the parentage. The form once produced had the hereditary character of a species. It had endured for four years. By analogy with similar changes in other plants, we were justified in assuming that it would reproduce itself indefinitely from seeds, as it had done by offsets; and again we had the recognized character of a species.

The most interesting deduction, however, from the facts now presented, was that it is not necessary to assume that every species sprang from one parent form, and from this one centre of origin spread by long lapses of time over a wide extent of country. We see that identical forms may appear simultaneously in localities widely separated; and, the circles meeting, cover a district in a comparatively short time. There would, of course, still have to be explained how the original forms from which these modern variations sprung, first had such a wide distribution, but that was a question which must wait for its own facts to properly solve. This difficulty could not invalidate what we saw must be a truth, that in these modern times new and identical forms do appear simultaneously in widely separated localities.

Influence of Temperature on the Separate Sexes of Flowers.—Mr. MEEHAN referred to his former observation, recorded in the Proceedings, that the male flowers in *Amentaceæ*, and other diœcious plants would grow, become perfectly developed, and mature the pollen under a temperature wholly insufficient to excite the growth of the female flower, which would remain undeveloped until a warmer temperature ensued. He had shown that the infertility of hickories, oaks, walnuts, hazelnuts, and other plants, a complaint common among orchardists in our country, arose from this fact, there being very little or often no pollen to fertilize the flowers in seasons when a few moderately warm days in winter would bring the aments to perfection a month or even months before the female flowers grew. This season we had no warm winter days, and at this time, middle of April, the aments in the hazelnuts and the female flowers were maturing together.

Mr. Meehan added that when he first reported these observations to the Academy he believed them wholly original, but he had since noted that similar observations had been communicated to the Horticultural Society of London, on the 18th of February, 1823, by Rev. George Swayne. "I entertain," says he, "a strong suspicion that the very frequent failures of the filbert crop (Mr. Williamson tells us that they totally fail three years out of five) are in great measure occasioned by a deficiency either in number or in power of the male blossom." He remedied this by experiment, by getting aments from other trees and hanging them in the trees that had lost them. This gentleman, however, did not apparently perceive the underlying principle that it took less heat to perfect the male flowers than the female flowers of the same species. It was quite possible this generalization might be carried out of the region of amentaceous or allied plants, and carried to a wide range of vegetable species, or even into zoology.

APRIL 28.

Mr. EDW. POTTS in the chair.

Fourteen persons present.

A paper entitled "On the genus Aphredoderus," by Willis S. Blatchley, was presented for publication.

Mr. Philip Laurent and the Rev. J. R. Danforth, D. D., were elected members.

Elasticity in the Fruit of Cactaceæ.—At the last meeting of the Botanical Section, Mr. THOMAS MEEHAN exhibited fruit of *Mamillaria Heyderi*, and remarked on the elastic characters of this and other species. This *Mamillaria*, under culture, flowers in April

or May, and, after flowering there is no sign of any development in the fruit. The ovarium is, indeed, buried between the closely appressed walls of the bases of the mammæ. Here they remain, undiscernible, till just before the next flowering season, when they suddenly emerge, and in a single night apparently stretch out to their full length. All attempts, however, to get at the exact time of development had failed, for the fruit was always of full length when first observed. In this species, the fruit is about two inches in length, clavate and incurved, and, as they are bright red, and more than double the length of the mammæ, and produced in considerable numbers, the effect on a plant where they were wholly absent a few days before, is very striking. This same sudden appearance of the fruit a year after the ovaria had been fertilized, has been noticed in *Mamillaria Nuttallina*, and some Mexican allied species. That the sudden development is the result of an elastic projection, and not of a proper growth, is manifest from the fact that the fruit is mature from its first appearance, has its dark red color, and succulence, and the seeds are perfect in color and size. Growth has to finish, in all fruits, before maturity is reached. A related form of elasticity has already been recorded by him in the *Botanical Gazette*. He has noted that after the maturity of the fruit of *Opuntia Bigelovii* the seeds are projected from the apex, and run down the sides of the fruit like lava from a burning mountain. In a letter to the speaker, Dr. Engelmann a short time before his death, referred to this observation as a matter of great importance as explaining a fact for which he had never been able to account, that fruit evidently seed-bearing, had generally been found by him to have no seed when cut open.

Mr. Meehan remarked that cases where ovaria, though fertilized, would remain a year without signs of growth, were not unknown. Indeed, large numbers of Coniferæ, and species of *Quercus* or oak had especially this peculiarity. There was often little or no growth in the fertilized fruit till the second year.

He knew of no author who had made any mention of this sudden and elastic development in the fruit of the Cacti, though the fact must surely have come within the view of some observers. Pfeiffer, Decandolle, Zuccarini, and other leading writers on Cactaceæ, seldom make any reference at all to the fruit, while Dr. Engelmann, who, of all others, has given us the most of what we do know in reference to this interesting part of the history of this plant, simply says in a few instances that the "fruit matures about the same time with the opening of the flowers." He had however, nearly perceived the fact in one instance. He notices in *Plantæ Lindheimerianæ* that in this very species (he then regarded it as *M. applanata*) "the scarlet fruit is still persistent, and forms an outer circle," while the new flowers are opening; and in the Botany of the Mexican Boundary, p. 9, referring to a closely allied species, *M. micacantha*, he says: "Fruit ripening

the second spring and summer, till then hidden between the bases of the surrounding tubercles, and for the greater part buried in the tissues of the plant; in spring the young fruit suddenly (in one or two weeks) grows to its full size, 9–12 or even 15 lines long, protruding far above the tubercles, and forming an interior (exterior?) scarlet circle, around the inner circle of rose-colored flowers." He did not perceive that the development of the fruit was not a growth, but the emergence and stretching out of structure the actual growth of which had already been matured; that it was an elastic and not a growing fruit.

MAY 5.

Mr. JOHN H. REDFIELD in the chair.

Twenty-one persons present.

The following papers were presented for publication:—

"On the Air-bladder of Fishes," by Charles Morris.

"A Review of the Genus Phrynosoma," by Alan F. Gentry.

Spawning of Fulgur perversus.—Mr. JOS. WILLCOX remarked that during the month of March, 1884, and recently, during the past March, in Clearwater Harbor and Sarasota Bay, in Florida, he observed many egg-cases (more than a hundred) of *Fulgur perversus*, both recently completed and during the process of their formation.

When completed, one end of the string of egg-cases floats freely in the water, while the small end is fastened to a shell under the sand. Being thus anchored it is not liable to be removed from its original position by the force of the tide. Whenever both ends of the egg-case are found to be under the sand, the middle portion being above the surface in the form of a loop, the parent conch will always be attached to one of the ends, but invisible to the beholder. All the processes connected with the subject of the reproduction of this species are performed under the sand, until the egg-cases are completed. When about to spawn, a place is selected where the sand is not packed hard. At that time a disposition is manifested to assemble in communities, usually upon a sand-flat where the water is never deep, and where the receding tide leaves the egg-cases dry and exposed to the warm rays of the sun during a portion of each day. Many egg cases, however, are to be seen, which are always submerged. In such instances the eggs may require a longer time for their development. Although, during the early part of April, many egg-cases were observed that were completed, in no instance were the young shells found to be developed in them.

When the mollusk is about to spawn, it first descends into the sand deeply, and attaches the egg-case to a bivalve shell. As the

process of extrusion permits, it ascends until the small end of its shell or siphon reaches the surface of the sand, so that it may respire the water freely. In this position it remains until the spawning is completed, during which process the body is protruded from its shell to a great extent. Only four or five of the cells or capsules were observed to exist in the body of the female at one time, which were closely compacted there, occupying little space; but, after extrusion, each cell becomes enlarged in thickness, being swollen by the introduction of water. During the process of formation, the egg-case is forced upward, appearing in the form of a loop above the sand, though no portion of the parent is then visible.

This species commences to spawn early in life. One egg-case was observed, the cells of which were about a half inch in diameter, the shell of the parent being only three and a half inches long. If handled gently, when dug from the sand, the conch does not withdraw its body into its shell; but, if it is injured, it will quickly eject all the egg-cells from its body, and close its operculum. As only four or five of the egg-cells are found in the body at one time, in the process of formation, it is presumed that the whole series of cases require a long time in their development.

MAY 12.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Twenty-four persons present.

The manuscript diary of Wm. Bartram was presented to the library by Mr. Meehan. It covers the period from 1802 to 1822, and contains notes on meteorology and natural history, especially ornithology.

A paper entitled "A Review of the American Genera and Species of Mullidæ," by Edw. A. Hall and J. Z. McCaughan, was presented for publication.

MAY 19.

Mr. EDW. POTTS in the chair.

Fifteen persons present.

Erythrite, Genthite and Cuprite from near Philadelphia.—Prof. H. CARVILL LEWIS stated that during the Saturday excursions of his class in mineralogy, a number of new mineral localities had been discovered, three of which were of sufficient interest to be recorded.

ERYTHRITE.—Erythrite, the beautiful and rare arsenate of cobalt, not heretofore recorded as occurring in North America, was

found at the Wheatley lead mines, south of Phœnixville. It occurs here in veins and incrustations of a beautiful rose-pink color. Under the microscope these incrustations are shown to be for the most part composed of minute globular rosettes of crystals, while earthy and fibrous masses also occur. The mineral was found to fuse easily in the flame of a Bunsen burner, coloring the flame pale grayish blue, the color of burning arsenic. A borax bead was colored deep blue, proving the presence of cobalt. The erythrite was associated with fluorite and blende. The specimens were collected by Mr. L. Woolman.

GENTHITE.—Genthite, a hydrous silicate of nickel and magnesia, was discovered in emerald-green coatings on the Schuylkill Valley Railroad, about a hundred feet north of the steatite quarry at Lafayette, just outside the city limits. It occurs on an actinolite rock in thin coatings, which, under the microscope, show the mammillary and stalactitic structure characteristic of genthite. Fused with borax, it gives a bead which is violet-brown in the oxidizing flame, and in the reducing flame is reduced to gray metallic particles, these reactions being characteristic of nickel. The genthite is associated with the numerous magnesian minerals which have made the steatite quarry so well known. Efflorescences of epsomite and veins of asbestos were found within a few feet of the genthite.

The discovery of genthite has a geological interest in demonstrating the presence of nickel in the serpentine belt which here crosses the Schuylkill. Some years ago Mr. T. D. Rand [1] had found a single specimen of millerite, another nickel mineral, in capillary crystals in the dolomite at the same locality. With this exception, nickel had not been known in this. serpentine belt. Chromic iron and other chromium minerals are, however known to occur in several localities in the same zone of serpentine, and the association of chromium and nickel is well known. The serpentines of Cornwall, the Alps, the Vosges, and of hundreds of other localities, contain both chromium and nickel. Dr. T. Sterry Hunt states [2] that the serpentines of his third (Green Mountain) series, which he refers to the lower Silurian age, are "marked by the almost constant presence of small portions of the oxides of chrome and nickel," a character which distinguishes them from the serpentines of the Laurentian series, which are usually free from these metals. Dr. Hunt, however, fails to identify the serpentine and steatite of Lafayette with his Green Mountain series, but supposes it to belong to another horizon,[3] refusing to believe that it was derived from an eruptive rock.

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[1] Proc. Min. and Geol. Sec. Acad. Nat. Sci. Phila., 1877.

[2] Chemical and Geological Essays, 1875, p. 32.

[3] The Geological History of Serpentines. Trans. Roy. Soc. Canada, 1883, i, p. 171.

Yet the presence of chromium and nickel in serpentine are facts in favor of its eruptive origin. For very many serpentines are derived from peridotite, as has been clearly shown by recent work in microscopic lithology. Most peridotites, whether meteoric or terrestrial, as the numerous analyses collected by Dr. M. E. Wadsworth [1] demonstrate, contain chromium and nickel. Most stony meteorites contain these same elements, and even the iron meteorites, in which the presence of nickel is so characteristic, frequently contain chromium. The late Dr. Lawrence Smith has described [2] nodules of chromite in meteoric iron, and has described a new sulphide of chromium and iron, under the name of Daubréelite,[3] peculiar to meteorites, and, as he believes, almost constantly present.[4] Chromite is well known to occur in terrestrial eruptive rocks. The association of nickel and chrome has previously been noticed in Pennsylvania at Wood's Chrome Mine, Lancaster County, where genthite [5] (described as nickelgymnite) was originally found. Genthite is associated with chromite also at Webster, Jackson County, North Carolina, where it forms handsome apple-green specimens incrusting chromite, and it is said to have a similar association at Malaga, Spain. Zaratite, a carbonate of nickel, occurs with chromite in West Nottingham, Chester County. Genthite has also been found at two other chrome-ore mines in Lancaster County,[6] but until now not elsewhere in this State.

Cuprite.—Bright vermilion-red earthy incrustations of cuprite, were noticed at Frankford, Philadelphia, in the quarries of hornblendic gneiss, so well known to mineralogists. This red oxide of copper here sometimes forms a coating on bornite, which latter is a beautiful, and somewhat abundant, mineral, at these quarries. The cuprite has in this association a peculiarly resinous lustre, and the specimens collected closely resemble red sealing-wax.

Bothriocephalus in a Trout.—Prof. Leidy remarked that through Dr. B. H. Warren he had recently received from the Smithsonian Institution, several vials with tape-worms, obtained by Mr. L. M. Turner, from a trout, *Salvelinus* ——?, at Ft. Chimo, Ungava. One of the vials contained eight worms ranging from 3 to 8 inches long, together with fragments of others; and was labeled, "Passed from a Trout, caught in the river, August 14, 1882." The worms belong to a species of *Bothricephalus* or *Dibothrium*, apparently different from either the *D. infundibuliforme* or *D. proboscideum*, found in *Salmo salvelinus*, *S. salar*,

[1] Mem. Mus. Comp. Zool. Cambr., xi, 1, Lithological studies, tables.

[2] Amer. Jour. Science, xxi, 1881, p. 461.

[3] Amer. Jour. Science, xii, 1876, p. 107, and xvi, 1878, p. 270.

[4] Original Researches, 1884, p. 543.

[5] Keller-Tiedemann, Nordam. Monatsbericht, iii, 488.

[6] Report B, Second Geolog. Survey of Penna., p. 118.

S. trutta, and other fishes of the kind. The specimens are all mature; the segments from near the head throughout being distended with brownish eggs. The characters of the worm are as follow:—Body linear, band-like, widest just behind the head, and gradually narrowing to the posterior extremity, thickened along the middle and to a less degree along the lateral borders, which are narrowly obtuse at the free edge, apparently cóntinuous but irregularly crenulate; the broad surfaces transversely wrinkled, with the lateral borders defined from the middle by longitudinal striæ; anterior extremity wider and transversely convex; posterior extremity obtusely rounded. Head small, oval, equitant across the anterior border of the body, with an oval bothria fore and aft, directed obliquely from the broad surfaces of the body. No distinct neck. Segments of the body commencing immediately after the head, wider than long, indistinctly defined at the lateral margins and most marked transversely along the middle of the body, becoming narrower and slightly longer at the posterior part of the latter, fertile throughout, and furnished on one side of the body, in the median line, with a prominent penal papilla and just behind with a genital pore. Animal whitish with a median chain of brownish spots due to the ova-distended uteri.

In a specimen of eight inches in length, the anterior extremity of the body is 3 mm. wide; at the middle 2 mm.; and at the posterior extremity 1·5 mm. The head measures 0·16 mm. transversely and 0·18 mm. deep or long on the broad aspect of the worm. The segments generally measure about 0·625 mm. long. The ova are brownish, oval, and 0·04 mm. long by 0·024 broad.

The second vial contains a single worm, and is labeled, "Taken from the intestine of a Trout, Aug. 29, 1882." This worm I suspect to represent an immature stage of the former. It is 30 mm. long, and in shape resembles a fluke-worm or a leech. It is elongated elliptical, flat, widest in front, with the lateral margins apparently entire, the broad surfaces transversely striated, and longitudinally divided in three bands, with the median band indistinctly divided into segments, on one surface in the median line provided each with a minute pore. Head oval, situated fore and aft across the anterior transversely convex border of the body; with a minute oval bothria fore and aft. Caudal extremity narrowest, transversely convex at the end, and emarginate or with a pore. Breadth at fore-part 3 mm.; at back part 2 mm. The species may be named *Bothriocephalus* (*Dibothrium*) *cestus*.

The following were ordered to be printed:—

ON THE AIR-BLADDER OF FISHES.

BY CHARLES MORRIS.

The generally accepted explanation of the use of this singular organ, that it serves to enable the fish to readily rise and sink in the water, while it is in all probability true in a measure, has undoubtedly been too greatly extended. It is usually offered as applying generally to fishes with an air-bladder, with little regard to the fact that in many cases the air-bladder is too small to serve any useful purpose as a gravity organ. This being the case, some further examination into its functions and organic relations seems not amiss.

Cuvier tells us that "the most obvious use of the swim-bladder is to keep the animal in equilibrium with the water, or to increase or reduce its relative weight, and thereby cause it to ascend or sink, in proportion as that organ is dilated or compressed. For this purpose, the fish contracts the ribs or allows them to expand." This is, however, not always the case, for in many cases the bladder is provided with compressing muscles, and, as Van Der Hoeven says: "In many fishes it is difficult to show how they are in a condition to expand the bladder and to rarefy the air." Cuvier says further: "With regard to the presumed assistance which the swim-bladder affords in respiration, it is a fact that, when a fish is deprived of that organ, the product of carbonic acid by the branchiæ is very trifling; but there is no sufficient foundation for assuming that it offers any analogy to the lungs." This is no doubt true as regards the usual condition of the organ. It may perform some function in facilitating the exchange of gases in the blood, but this is not a direct respiratory function. In some cases, however, its function is directly respiratory, and in a few instances it constitutes an actual lung, closely approaching the Batrachian lung in organization.

A similar view is offered by the latest writers. Günther, in his "Study of Fishes," remarks that "this organ serves to regulate the specific gravity of the fish, to aid it in maintaining a particular level in the water, in rising or sinking, in raising the front part of its body or depressing it as occasion may require." This theory is based on hypothesis, since it would be no easy

matter to prove or disprove it by experiment. As above said, however, it is in consonance with physical laws in certain cases, and in such cases it very probably gives a correct view of the function of the organ. Yet there are many cases in which the small size of the organ must render it nearly or quite useless for any such purpose, while its entire absence in very many instances of active species of fish, shows that this function is of no special value to the fish tribe as at present constituted, and suggests that the original purpose of the air-bladder must have been very different from that here surmised. A general examination of the subject may aid us in gaining some definite conception of the character of this original function.

The air-bladder of fishes is an internal sac, occupying usually the dorsal aspect of the body, and in some cases connected with the intestinal canal by a pneumatic duct, though in the great majority of cases this duct is wanting, or its cavity is closed. Thus, most generally, the bladder is a closed sac, containing gas which could only have come from the blood-vessels, with which it is abundantly provided in the form of *retia mirabilia*. This gas, in fresh-water fishes, is nearly pure nitrogen. In ocean fishes, particularly the deeper swimmers, oxygen is in excess, and has been found in some instances to constitute as much as 87 per cent. of the contents. Some naturalists advance the singular theory that the absolute weight of the fish may be increased or diminished by compression or dilation of this gas, as if the same quantity of gas could change its weight by a variation in its density. But that the relative weight of the fish, or its displacement of water, might be changed by a variation of its body-volume, through a variation in the state of compression of the air-bladder, is unquestionable, though in those numerous cases where the bladder is very small its influence must be of very little aid in the movements of the fish.

In addition to its use in aiding the fish to ascend or descend in the water, its dorsal position must also act to keep the back of the fish uppermost. In certain cases it also doubtless subserves another gravitative purpose—that of elevating or depressing the anterior region of the body, at the will of the fish. This is possible in those cases in which the bladder has a considerable longitudinal extension. In some cases, it is prolonged into the tail of the fish. In others, it sends processes

into the head. And in certain instances, the ductless bladder is divided by constrictions into two or three compartments, in the longitudinal direction. In these cases, the fish may have the power to shift the gaseous contents of the bladder forward or backward at will, and thus, by a variation in the weight of the different regions of the body, to change its line of motion from a horizontal to a more or less inclined direction. Yet such a function cannot be of any absolute importance to the fish, or preparation for it would be far more general than we find it.

If we consider the conditions under which the air-bladder exists in fishes, it becomes exceedingly doubtful that it was originally evolved as a gravity-organ. In one important order of fishes, the Elasmobranchs, it does not exist. No shark or ray possesses this organ. In the main body of the fish tribe, the Teleostean, its occurrence and character are very irregular. In those which possess it, it exhibits an extraordinary variation in shape, size and relations to the body, and this sometimes between closely related genera and species. With some Teleosteans the air-bladder has an open pneumatic duct, connecting with the œsophagus, or in a few cases with the stomach. With others this duct exists, but its cavity is closed. In some cases it is reduced to a fine ligament. In many others no trace of it exists. The air-bladder itself is a hollow sac, composed usually of two tunics, and compressible, in whole or in part, by the aid of muscles on its external surface, or by other means. It is situated in the abdominal cavity, above the intestinal canal, and outside the peritoneal sac, its ventral surface being invested by a fold of the peritoneum. In some fishes it is almost loose in the abdominal cavity. In others it is intimately adherent to the vertebral column and the abdominal tissues. In many cases it is enclosed in osseous capsules formed by the vertebræ, which seem capable of exerting a pressure upon it. In addition to the cases of its longitudinal division into chambers, it is sometimes composed of two lateral divisions, and in some families there is an extraordinary development of lateral appendages.

Its occurrence is as irregular as its shape and relation to the body. In this respect, it varies remarkably in species of the same genus. Thus the mackerel has no air-bladder; yet one exists in *Scomber pneumatophorus*, a species which in every other respect very closely resembles the mackerel. So *Polynemus*

paradiseus is without an air-bladder, while all other species of the genus have one. The same condition occurs in related genera. Thus in the species of *Sebastes* the air-bladder is very large, while in the next genus of the family it is scarcely the size of a pea.

These examples will serve to show the great diversity in the shape, size and condition of this organ. And it may be said here that these variations have no appreciable effect upon the velocity and activity of the fish. Those that have no air-bladder seem in no respect at a disadvantage, as compared with those that have one. Again, it may be said that no animal organ whose function is of known importance presents such extraordinary modifications. In the heart, lungs, brain, etc., there is one shape, position and condition of greatest efficiency, and throughout the lower forms we find a steady and undeviating advance towards this condition. There is in all these organs a persistent movement towards homogeneity; not towards heterogeneity, such as we find in the air-bladder. The natural conclusion from this would be that the air-bladder is not an organ of functional importance, while its absence from many fish, and great diversity in others, indicates that it is of minor value to the fish tribe. If it is of absolute necessity to any fish as a gravitating organ, why is it not necessary to all, and why has it not developed into some shape and condition of greatest efficiency? The existence of the air-bladder is proof that it has had, at some time, a function of considerable importance; but its many variations go to prove that it has ceased to perform any essential function, and is on the road towards extinction. On no other theory can we explain its great diversity in nearly related species.

That the air-bladder is degenerating we have evidence in cases like that above mentioned, where it is no larger than a pea. It is difficult to imagine that this minute organ is of any use to the animal. But no process of evolution can take place, except the organ is of use at every stage of its development. The natural conclusion is that the air-bladder evolved long ago, under some influence not now active, and is now on the road towards extinction, being retained only in those forms where it serves some minor purpose, but being nearly or quite obliterated in forms in which it is put to no practical use. This secondary use of

degenerating organs is not uncommon. We have one instance in point in the adaptation of the embryonal gill-arches of mammals to other uses. Of these secondary employments of the air-bladder one seems to have some connection with the organ of hearing. Another seems to be to change the direction of the fish-body from the horizontal towards the vertical line. As a general rule, when present, it may fix the special buoyancy of the fish-body, and, by its situation near the back of the fish, may aid to keep the dorsal surface upward in the water. This may be the purpose of its lateral appendages, as the former is of its longitudinal extension. Yet the fishes which have no air-bladder seem none the worse off in any of these particulars. It is impossible that such an organ could have developed to perform functions which were satisfactorily performed without it, and it seems more probable that it is an organ arrested at various points in its process of degeneration, as it proved serviceable in some minor function.

If, then, we may look upon the air-bladder as an organ which has partly or wholly lost its original function, the question follows, what was that function? There are certain good reasons for believing that the breathing of air was the original purpose of this organ. In mature Teleosteans this is occasionally indicated by the existence of a pneumatic duct connecting with the œsophagus. It is true that this duct is usually of no functional use, and varies from partial to complete disappearance. But the fact is, that all fishes with an air-bladder possess a duct in the early stage of embryological development. In the mature stage it is lost by all Teleosteans except the Physostomes.

Thus embryological evidence indicates that one original function of the air-bladder was the introduction of external air into the body, a function which has now lost its importance. And the apparatus for compressing and dilating the bladder may have been originally developed as an aid in this function. Also the extraordinary development of *retia mirabilia*, in the inner tunic of many air-bladders, now used only to secrete gas into the interior, may be a survival of ancient pulmonary capillaries, which have changed their character with their function.

There are other reasons beyond those here given that the air-bladder was originally an air-breathing organ. Embryology points back to the condition of the primal fishes. But of these

antique vertebrates we have existing representatives in the Ganoids and the Elasmobranchs, and it is of interest to find that in these modern survivals of the ancient fish life, the Elasmobranchs are entirely destitute of air-bladders, both in the mature and the larval stage, while all Ganoids possess an air-bladder, which retains a fully developed pneumatic duct in the mature stage. And in the suborder of Dipnoi, the air-bladder is functionally active as a lung. It is well-known that counterparts of the modern Dipnoi existed in the Devonian age, and it is highly probable that they breathed air then as they do now. In fact, we have some warrant for the belief that the antique fishes were divided into two orders, as clearly by their breathing habits as by other characteristics, the Elasmobranchs breathing by gills only, while the Ganoids had developed a supplementary organ for an occasional breathing of the air.

If we compare the air-bladder with the lungs of the higher vertebrates, we find that its general condition in the Ganoids is that of a single cavity, with an effective duct opening into the dorsal side of the œsophagus. But there is an exception to this in the Dipnoi, and in *Polypterus*. In these, the duct connects with the ventral side of the œsophagus, as in the lungs of higher animals. Wilder shows that there is a series of forms, mostly Ganoids, leading from *Amia* and *Lepidosteus*, with the pneumatic duct entering the throat on the dorsal side, to *Lepidosiren*, in which it enters on the ventral side, as in lung-breathing animals.

In all the fishes just named the air-bladder functions as a lung. In *Polyterus* it has lateral divisions, and is probably used in air breathing, while in the Dipnoi it becomes a functional lung. In *Lepidosteus*, the American Gar-Pike, the air-bladder becomes cellular and lung-like. This fish keeps near the surface, and may be seen to emit air-bubbles. It apparently takes in a fresh supply. The American Bow Fin or mud-fish (*Amia*) has a bladder of the same lung-like character, and it has been seen by Wilder to come to the surface, open its jaws widely, and apparently swallow a large quantity of air. Wilder remarks that "so far as the experiments go it seems probable that, with both *Amia* and *Lepidosteus*, there occurs an inhalation as well as exhalation of air at pretty regular intervals, the whole process resembling that of the *Menobranchus* and other salamanders, and the tadpoles, which,

as the gills shrink and the lungs increase, come more frequently to the surface for air."[1]

The Dipnoi have the air-bladder developed into a true lung. Of these the Australian lung fish (*Ceratodus*), has but a single air-bladder, but this is provided with breathing pouches that possess a symmetrical lateral arrangement. It has no pulmonary artery, but receives branches from the *Arteria cœliaca.* It is supposed that this fish ordinarily breathes with the gills, but uses its lungs when the water has become thick and muddy, or is charged with gases from decomposing organic matter. Finally *Lepidosiren* and *Protopterus* have completely formed lungs, divided into two lateral chambers, and provided with a pulmonary artery. Their cellular structure nearly approaches that of the batrachian lung.

The facts here cited certainly seem to lead to the conclusion that the air-bladder was originally developed as an air-breathing organ, and only became adapted to other purposes when it had become no longer of value in this direction. We may find evidence in favor of this conclusion in the condition of the fishes which still use it as a breathing organ. With them the gill is the ordinary breathing apparatus. The lung is not called into use except when the water becomes foul or unaerated. It is a supplementary organ, which could be easily dispensed with if the fish should gain the habit of swimming in search of better aerated water. It is impossible to imagine that the air-bladder developed into a lung under the force of such a minor necessity as this. It is very much more probable that it was once an important breathing organ with these fishes, and has retained its functional value from its occasional use, but has become of minor importance, and has been largely superseded by the gill.

If now we ask, what were the conditions of life under which this organ was developed, and what were the later conditions which rendered it in great measure or entirely useless, some definite answer may be given. The question takes us back to the Devonian and Silurian geological periods, during which it is probable that its original development took place. In this era the seas were thronged with fishes of two distinct orders, the Elasmobranchs and the Ganoids, the former without, the latter with.

[1] For other instances of the same character, see Semper's "Animal Life," Note 75.

an air-bladder. This difference in organization was probably the result of some marked difference in their life habits. The Ganoids may, in their original state, have inhabited poorly aerated waters or waters otherwise ill-adapted to breathing, while the Elasmobranchs may have had their primordial habitat in clearer and purer waters.

But there werė other conditions which may have been the main influencing causes in the development of an organ for air-breathing. We know that the land was habitable during long ages ere it gained any vertebrate inhabitants. The presence of insects in Devonian and Silurian strata proves this. It must have possessed much food material, both vegetable and animal, and it is hardly probable that the active fish forms of the early seas made no effort to obtain a share of this food. Long ages passed during which we have no evidence of land animals higher than insects or snails. It is highly probable that many fishes gained the habit of leaving the water temporarily for the land in search of food during this period. We know that many fishes do so now, and that some even climb trees, in spite of the many dangerous foes that now exist on land. In the era referred to there were no such dangerous foes. Such fishes as left the sea for the land would find only food to repay their enterprise. Thus there must have been a powerful inducement for fishes to assume this habit.

The indications, however, do not lead to the idea that the original development of an air-breathing organ was due to occasional visits from sea to shore. Such an organ must have slowly developed under the pressure of less extreme changes of conditions. It probably arose through the effect of such influences as still act upon fish, and force them to occasionally breathe air; such as foul or muddy water, or a lack of proper aeration arising from any cause. Another important influence is the drying-out of pools, by which fish are left in the moist mud until the recurrence of rains, or are even buried in the dried mud for the six months of the dry season. Such is the case with *Lepidosiren*, which uses its lungs during this period. In certain other freshwater fishes, of the family Ophiocephalidæ, air is breathed while the mud continues soft enough for the fish to come to the surface, but during the remainder of the dry period it remains in a torpid state. In these fishes the air is breathed into a simple cavity in the pharynx, whose opening is partly closed by a fold of the

mucous membrane. In the family Labyrinthici the accessory breathing cavity becomes an organ, with thin laminæ or plates, which undoubtedly perform an oxygenating function. This organ is greatly developed in *Anabas scandens*, the Climbing Perch. In addition to these there are cases in which fish leave drying pools, and migrate for a considerable distance overland in search of water, with no breathing organ but the gills.

If even now, when the land is everywhere occupied with active and dangerous foes, so many fish find occasion to venture on shore, it is quite probable that in the early period, when it could be visited without danger, very many fishes may have paid temporary visits to the land. And if now, under this influence, and that of drying pools and stagnant water, many fish have acquired a partial air-breathing habit, this was far more likely to take place under the more favorable conditions of ancient times. It seems quite possible that the development of the air-bladder was due to influences of this character. The occasional habit of breathing air is quite common with fish, especially of fresh-water species. Cuvier remarks that air is perhaps necessary to every kind of fish; and that, particularly when the atmosphere is warm, most of our lacustrine species sport on the surface for no other purpose.

It may be even possible to draw a hypothetical scheme of the original process of development of the air-bladder as a breathing organ. Embryology indicates that its existence began in an eversion of the intestinal canal, in its œsophageal portion, and that this gradually became an air-bladder with its pneumatic duct. It may have had its primal form in a simple pharyngeal cavity, like that of the Ophiocephalidæ, partly closed off from the food-passage by a fold of the mucous membrane. A step further would reduce this membraneous fold to a narrow opening, leading to an inner pouch. From such a condition the development of the Ganoid air-bladder, with its pneumatic duct of greater or less length, is a probable and natural one, and is sustained by embryological evidence. Though we do not possess the intermediate steps, and the breathing organ of the Labyrinthici is a specialized apparatus aside from this line of progress, yet the breathing pouch of the Ophiocephalidæ is in the direct line of development of the Ganoid air-bladder. We can scarcely look upon it as in any sense a survival of the archæic air-breathing organ. It is more

probably a modern reproduction from the action of similar causes, of the first existing stage of an air-breathing apparatus. And though it is hardly probable that the reproduction is an exact one, yet it may not be very divergent from the original organ. Thus from a simple pouch in the wall of the œsophagus may have arisen, by successive steps, the air-bladder, with its pneumatic duct, its compressing muscle and its plexus of blood capillaries. And this may have unfolded, through further successive steps, several of which yet exist, into a lung like that of *Lepidosiren*. Thus we seem to possess existing representatives of every important phase in lung development, from that in which the simple wall of the intestine performed an air-breathing function, to the lung of the batrachian.

In this view of the case, the original lung was a simple, smooth-walled bladder, provided with abundant vessels to subserve blood-aeration, with muscles to aid in inhalation and exhalation, and with an air-duct opening into the œsophagus on its dorsal aspect. This dorsal connection may have arisen from the upward pressure of the air in the swimming fish, which would tend to give this position to the original intestinal pouch. But when any fish came to frequently visit the shore two new influences necessarily came into play. The effect of gravity on the growing organ would tend to drag it and its duct from the dorsal to the ventral position. And the increased use of the bladder in breathing must have required a more extended surface. It first grew cellular, then the cells became laterally-arranged pouches. Finally a constriction of the wall separated these lateral pouches, and two chambers were produced. Of every stage of this process instances still exist, and there is much reason to believe that the development of the lung followed the path here pointed out.

At the opening of the Carboniferous era there may have been many lung- and gill-breathing Dipnoi, finned Batrachians as we may call them, who spent much of their life on shore. And their habit of land-life would naturally be attended by a gradual change of the fins into better walking organs, from which by a long continued process of evolution, may have arisen the leg and foot of the primordial batrachian. For this purpose to become fully achieved, however, the development of an internal bony skeleton was necessary, and with the completion of this step of evolution the lung-breathing fish probably directly unfolded into the

batrachian. But from that time forward the dominion of the fish on the land must have steadily decreased. The fin could not compete with the leg and foot as an organ of land motion, and the Dipnoid fishes were probably driven back to the water. As a result of this change of condition a retrogressive evolution took place in the air-breathing organ. Some fishes continued to use it occasionally as a lung, of which we have instances in the modern Dipnoi. Yet with the Ganoids, as a rule, it probably never attained a lung-like development, and was used only for temporary breathing purposes. This is its condition in most of the few existing Ganoids. But with their successors, the Teleosteans, it has lost all air-breathing capabilities, and has passed through every stage of degeneration, from a condition closely resembling that of the Ganoids to complete extinction. And in this process of degeneration it has been, in certain cases, adapted to minor uses, some of the most probable of which have been above enumerated, while there may be others as yet unknown to us.

A consideration of the gaseous contents of the air-bladder may lead to a conception of one such possible use. It is somewhat remarkable that it contains nearly pure nitrogen in fresh-water forms, while in the deep-swimming sea fish oxygen forms its main contents, often to a very large percentage. There must be some sufficient cause of this difference of contents. It is not due to any difference in the gases contained in water at various depths, for the percentage of nitrogen is closely the same at all depths, while oxygen diminishes in quantity from the surface downward. Thus, if its contents depended on the relative quantity of gases present, nitrogen should predominate below as well as above. It is probable, however, that the presence of oxygen in the bladder of deep-sea fishes is really due to the smaller quantity of oxygen there present in the water. The bladder may serve as a complementary aerating apparatus, as suggested by Semper, a reservoir of oxygen for the use of the fish during sleep, or when, from any cause, not actively breathing, or in poorly aerated water. Such a function would be of little or no importance to surface fish, which can readily obtain water rich in oxygen. And these fish, for this reason, may secrete only the useless nitrogen into the air-bladder. But for deep-water fishes this function may be highly necessary. When actively breathing they probably obtain little more oxygen

than is required for immediate use. And the small excess gained may be secreted into the air-bladder as a reservoir, to be taken up again by the blood during inactivity of the breathing function. This seems probable from what Cuvier tells us, that when a fish is deprived of the swim-bladder, the product of carbonic acid by the branchiæ is very trifling. We cannot imagine such a result unless the bladder in some way supplies oxygen to the blood. If this be the case, the air-bladder still performs, in an indirect manner, its probable original function of a breathing organ.

If the hypothesis here offered be a well-founded one, an interesting conclusion as to the process of organic evolution involved may be taken. For we would have the air-breathing function at first performed by the unchanged walls of the œsophagus. Then this became pouched. Then the pouch became constricted off, with a duct of connection. Then the duct disappeared, as the original function vanished, and what was originally a portion of the wall of the intestinal canal, became a separate internal sac. Then this sac decreased in size, until in some instances it became a closed internal bladder, of the size of a pea, far removed from and utterly disconnected with its place of origin. Finally it completely vanished. This process, if correctly drawn, certainly forms a very remarkable organic cycle of development and degeneration, which probably has no counterpart of a similarly striking character in the whole circle of organic life.

ON THE GENUS APHREDODERUS.

BY WILLIS S. BLATCHLEY.

With a view to ascertaining whether more than one species of Pirate Perch (*Aphredoderus* Le Sueur) exists in our waters, I have compared numerous specimens from various localities of the United States, in the Museum of the Indiana University.

I find individual variations, but no constant differences distinguishing Eastern, Western or Southern forms of this species from one another.

Since the variation in the position of the vent, upon which the nominal genus *Sternotremia* Nelson was based, has been shown by Profs. Forbes and Jordan to depend upon the age of the fish, there is, in my estimation, but one species, *Aphredoderus sayanus*, belonging to the genus.

The following is the synonymy of the genus and species:—

Aphredoderus (Le Sueur) Cuv. & Val., Hist. Nat. des Poiss., ix, 1833, 445 (*gibbosus*).

Aphredodirus Cope, Proc. Amer. Phil. Soc., 1870, 455 (emended orthography).

Sternotremia Nelson, Bull. Ill. Lab. Nat. Hist., i, 1876, 39 (*isolepis*).

Aphododerus Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 101 (emended orthography).

Asternotremia (Nelson), Jordan, Bull. U. S. Nat. Mus., x, 1877, 51 (*isolepis*. emended meaning).

Aphredodirus Jordan, Proc. Acad. Nat. Sci. Phil., 1877, 60 (emended orthography).

Aphredoderus sayanus.

Scolopsis sayanus Gilliams, Jour. Acad. Nat. Sci. Phila., iv, 1824, 81 (Harrowgate, Pa.).

Aphredoderus sayanus De Kay, N. Y. Fauna, Fishes, 1842, 35; Baird, Ninth Smithson. Rept., 1855, 326 (Cedar Swamp Cr., Cape May Co., N. J.); Günther, Cat. Fish. Brit. Mus., i, 1859, 271; Abbott, Proc. Acad. Nat. Sci. Phila., 1861, 95 (Camden, N. J., Habits of *A. sayanus*); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 274 (Streams of Lowlands of N. J. and Del.); Putnam, Amer. Nat., Jan., 1872, 85; Jordan & Copeland, Check List, 1876, 130; Hay, Proc. U. S. Nat. Mus., iii, 1880, 501, 515 (Noxubee R.); Jordan, Geol. Rept. Ohio, iv, 1882, 920; Hay, Bull. U. S. Fish. Com., ii, 1882, 64, 74 (R. at Vicksburg and Memphis, Big Black R., Pearl R., Tombigbee R., Chickasawha R.); Jordan & Gilbert, Synopsis Fish. N. A., 1882, 460; Bean, Cat. Fish. International Fish Exhibition, London, 1883, 82 (Vaughan's, Miss.); Forbes, Studies of Food of Fishes, Ill. Lab. Nat. Hist., 1883, 66

(Anatomy and food of *A. sayanus*); Gilbert, Proc. U. S. Nat. Mus., 1884, 204 (Salt Creek, Brown Co., Ind.).

Aphredodirus sayanus Cope, Proc. Amer. Phil. Soc., 1870, 455 (Tributaries Neuse R., Wake Co., N. C.).

Aphododerus sayanus Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 101 (Delaware R., Neuse R., Miss. R. in Louisiana, Flint R.); Jordan, Annals N. Y. Lyc. Nat. Hist., xi, 1877, 368 (Coosa R.); Jordan, Amer. Nat., Oct., 1877, 613; Jordan, Man. Vert., 2d ed., 1878, 249; 3d ed., 1880, 249; Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 41, 47, 89 (Neuse R., Chattahoochee R., Alabama R.); Jordan, Bull. Hayden's Geol. Surv., iv, 1878, 434.

Aphredoderus gibbosus (Le Sueur), Cuv. & Val., Hist. Nat. des Poiss., ix, 1833, 448 (Lake Pontchartrain).

Sternotremia isolepis Nelson, Bull. Ill. Lab. Nat. Hist., i, 1876, 39 (Calumet R., Ill.); Jordan & Copeland, Check List, 1876, 139; Jordan, Proc. Acad. Nat. Sci. Phila., 1877, 61.

Asternotremia isolepis (Nelson), Jordan, Bull. U. S. Nat. Mus., x, 1877, 51 (Tributaries Ohio R.).

Aphododerus isolepis Jordan, Annals N. Y. Acad. Sci., i, 1877, No. 4, 101 (Wabash R., Maumee R., Calumet R., Streams of S. Ill., Arkansas R.); Jordan, Bull. Ill. Lab. Nat. Hist., ii, 1878, 48 (Calumet R., Wabash R. at Mt. Carmel, Streams of S. Ill.; Variation in position of vent); Forbes, Bull. Ill. Lab. Nat. Hist., ii, 1878, 77, 84 (Food of *A. isolepis*, and account of change in position of vent); Jordan, Man. Vert., 2d ed., 1878, 249; Jordan, Bull. Hayden's Geol. Surv., iv, 1878, 434.

Aphrodedirus cookianus Jordan, Proc. Acad. Nat. Sci. Phila., 1877, 60 (Sawyer's Cr., Kendallville, Ind.).

Aphododerus cookianus Jordan, Bull. U. S. Nat. Mus., ix, 1877, 49 (Wabash R.); Jordan, Bull. U. S. Nat. Mus., x, 1877, 52.

Asternotremia mesotrema, Jordan, Bull. U. S. Nat. Mus., x, 1877, 52 (Little Red R., Arkansas).

A REVIEW OF THE GENUS PHRYNOSOMA.

BY ALAN F. GENTRY.

Phrynosoma Wiegmann, in Oken, Isis, xxi, 1828, p. 367; Wagler, Naturl. Syst. Amph., 1830, p. 145; Gray, Cat. Liz. Brit. Mus., 1845, p. 227; Dumeril & Bibron, Erpet. gener., iv, 1837, p. 311; Holbrook, N. A. Herp., ii, 1842, p. 85; Fitzinger, Syst. Rept., 1843, p. 78; A. Dumeril, Cat. Meth. Rept., i, 1851, p. 78; Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 354; Girard, Herp. U. S. Expl. Exped., 1858, p. 388; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., 1870, p. 217; Cope, Check List N. A. Batrach and Rept., 1875, p. 49.

Anota Hallowell, Proc. Acad. Nat. Sci. Phila., 1852, p. 182.

Gen. Char.—Head short, cordiform, elevated at the vertex, and armed behind and on the sides with strong spines, variable in length and number. Cephalic plates small, rugose and polygonal. Palatine teeth wanting. Gular fold present. Auricular aperture inconspicuous in certain species, or entirely absent. Body short, rounded, depressed, and ordinarily fringed. Dorsal and caudal crests lacking. Limbs short, digits moderately developed. Tail comparatively short. Femoral pores present, but anal wanting.

This genus, which is probably the best defined and the most strikingly distinct of its family, is wholly restricted to North America. Its northernmost range, so far as has been determined, is the boundary line between the United States and the British possessions, Dr. Coues having met with it in the region of the Milk River during the summer of 1874, while its southern limit is the scope of country that occupies the terminus of Mexico. Montana, Dakota, Nebraska, Kansas, Indian Territory, Texas, and the countries stretching thence to the Pacific, are the only portions of the Union, as far as are known, that have yielded evidences of its existence. Of the many species which have been described from this area, [illegible] twelve [illegible] as valid, seven being denizens of the United States and the [illegible] of the table-lands of Mexico.

While [illegible] of the [illegible] separation of [illegible] Girard, and by [illegible] they are [illegible] division. [illegible] by consider- [illegible] representatives,

with their most salient marks of distinction, I shall now proceed to tabulate.

Synopsis of Species.

I. Nostrils lateral; opening on the anterior extremity of the superciliary ridge.

A. A single row of pyramidal scales at the periphery of the abdomen; gular scales subequal; abdominal scales smooth.

1. Cephalic spines very short and tubercular; occipitals less prolonged than the longest of the temporals, posteriorly; head broader than long. *Douglassi.* 1.

2. Cephalic spines of medium length; occipital spines directed obliquely upwards, and a little less prolonged than the longest of the temporals, posteriorly; head broader than long. *Boucardi.* 2.

3. Cephalic spines of medium length; occipital spines horizontal, more prolonged than the longest of the temporals, posteriorly; head as broad as long. *orbiculare.* 3.

B. Two rows of pyramidal scales at the periphery of the abdomen; three or four rows of enlarged pointed gular scales upon each side of the median line.

1. Abdominal scales smooth; cephalic spines to the number of twelve or thirteen; occipital spines horizontal or nearly so. *coronatum.* 4.

2. Abdominal scales carinated; cephalic spines eight in number; occipital spines vertical. *asio.* 5.

II. Nostrils anterior; situated within the superciliary ridge; two rows of enlarged gular scales, one row on each side of, and distant from, the median line.

A. Two rows of pyramidal scales at the periphery of the abdomen; auricular opening conspicuous.

1. Abdominal scales carinated, sometimes smooth or nearly so; occipital spines directed obliquely backward, much longer than the longest of the temporals, from which they are separated by one or two flattened scales. *cornutum.* 6.

2. Abdominal scales carinated; cephalic spines forming with the inframaxillary plates a continuous circular series; occipital spines projecting posteriorly as far as, and not separated from, the longest of the temporals. *regale.* 7.

B. One row of pyramidal scales at the periphery of the abdomen; auditory aperture conspicuous.

a. Abdominal scales carinated; tail very short, not equal in length to the femur.

1. One temporal on each side strongly developed and conical, very much more prolonged posteriorly than the occipitals, which are small. *taurus*. 8.
2. Temporal spines moderate, flattened, four or five on each side, scarcely projecting beyond the occipitals, posteriorly. *Braconnieri*. 9.

b. Abdominal scales smooth; tail of ordinary length; occipital spines projecting beyond the longest of the temporals, posteriorly. *platyrhinos*. 10.

C. No pyramidal scales at the periphery of the abdomen; auditory aperture sometimes absent on one or both sides in *modestum*; always absent in *Maccalli*; abdominal scales smooth.

1. Occipital spines short, projecting about as far as the longest temporal, posteriorly; one row of enlarged gular scales next to the inframaxillary plates. *modestum*. 11.
2. Occipital spines very long and recurved, projecting much farther than the longest temporal, posteriorly; one row of enlarged gular scales on each side, distant from the inframaxillary plate. *Maccalli*. 12.

1. Phrynosoma Douglassi.

Agama Douglassi Bell, Trans. Linn. Soc. Lond., xvi, 1828, p. 105, pl. x; Harlan, Med. and Phys. Researches, 1835, p. 141.

Phrynosoma Douglassi Wagler, Naturl. Syst. Amph., 1830, p. 146; Gray, Griff. Anim. King., ix, 1831, p. 44; Wiegmann, Herp. Mex., 1834, p. 54; Dumeril & Bibron, Erpet. gener., iv, 1837, p. 323; Holbrook, N. Am. Herp., ii, 1842, p. 101, pl. xiv; Dekay, Zool. New York, iii, 1842, p. 31; Fitzinger, Syst. Rept., i, 1843, p. 78; Gray, Cat. Liz. Brit. Mus., 1845, p. 227; Aug. Dumeril, Cat. Meth. Coll. Rept. Mus. Paris, 1851, p. 78; Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 362, pl. vii, figs. 6-9; Aug. Dumeril, Arch. Mus. Hist. Nat., viii, 1856, p. 554; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 302; Allen, Proc. Bost. Soc. Nat. Hist., xvii, 1874, p. 69; Cope, Am. Nat., xii, 1879, p. 435.

Phrynosoma orbiculare Hallowell, Sitgreaves' Expl. Zuni and Col. Riv., 1853, p. 125, pl. viii and ix.

Tapaya Douglassi Girard, Herp. U. S. Expl. Exped., 1858, p. 398, pl. xxi, fig. 1–5; Baird, P. R. R. Rep., x, 1859, Gunnison & Beckwith's Route, Rept., p. 18; *Id.*, Williamson & Abbott's Route, Rept., p. 9; Cooper & Suckley, Nat. Hist. Wash. Terr., 1860, p. 294; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870. p. 226, pl. xi, fig. 5.

Tapaya brevirostre Girard, Herp. U. S. Expl. Exped., 1858, p. 397; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 302.

Tapaya Hernandezi Girard, Herp. U. S. Expl. Exped., 1858, p. 395; Baird, U. S. and Mex. Bound. Surv., ii, pt. ii, 1859, p. 8.

Tapaya ornatissima Girard, Herp. U. S. Expl. Exped., 1858, p. 396; Baird, U. S. and Mex. Bound. Surv., ii, pt. ii, 1859, p. 9; Baird, P. R. R. Rep., x, 1859, Whipple's Route, Rept., p. 38; Demeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 227, pl. xi, fig. 6.

Phrynosoma Douglassi, subsp. *Douglassi* Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of the 100th Meridian, v, 1875, p. 580; Coues, *op. cit.*, p. 590; Coues & Yarrow, Bull. U. S. Geol. Surv. of Terr., iv, 1878, p. 285.

Phrynosoma Douglassi, subsp. *ornatissima* Cope, Check List N. Am. Batrach. and Rept., 1878, p. 49; Yarrow, U. S. Geol. Surv. west of 100th Meridian, v, 1875, p. 581; Coues, *op. cit.*, p. 591; Coues & Yarrow, Bull. U. S. Geol. Surv. of Terr., iv, 1878, p. 286.

Phrynosoma Douglassi pygmæa Yarrow, Bull. U. S. Nat. Mus., v, 1882, p. 443.

Head broader than long; nostrils lateral, opening upon the anterior extremity of the superciliary ridge; cephalic spines small and tuberculous; occipital spines more prolonged than the longest temporal, posteriorly; last three or four sublabial scales on each side, enlarged and pointed; submaxillary plates small and subequal, about the size of the posterior sublabials; a conical scale at the angle of the mouth; gular scales nearly equal, the row next to the inframaxillary plates slightly largest; one row of pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back armed with several rows of spiny scales; tail of medium length, similar to back above, smooth beneath, and fringed laterally with conical spines.

Habitat.—Washington Territory, Oregon, California, Montana, Dakota, Nebraska, Kansas, Indian Territory, Texas, Wyoming, Colorado, Utah, and New Mexico.

A careful study of *Douglassi*, and an institution of comparison between its characters and those of *Hernandezi*, convince me that the two are identical. The row of enlarged gular scales

next to the inframaxillary plates, as given by Girard as a mark of distinction, is also found in *Douglassi*. The abdominal scales are spoken of as being acuminate, and such is the case with those of the upper portion of the belly in *Douglassi*, although lower down they are somewhat obtuse.

Between *Douglassi* and the subspecies *ornatissima* and *pygmæa*, of some authors, I can perceive no differences. Examinations of numerous specimens in the collection of the Academy of Natural Sciences of Philadelphia, from all parts of its extended habitat, convince me that there are no fixed discriminating characters, not even of size, as the smaller northern forms are found to grade imperceptibly into their larger southern neighbors. And, as *pygmæa* was described from the region of the Columbia River, and *ornatissima* from New Mexico, the former as small and the latter as large, and corresponding otherwise as they do with *Douglassi*, there is good reason for considering them only as extreme forms of this species.

2. **Phrynosoma Boucardi**

Tapaya Boucardi Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 225, pl. xi, fig. 4.

Head broader than long; cephalic spines of medium length; occipital spines directed nearly vertically upwards, not prolonged as far posteriorly as the longest temporal; sublabials small, increasing in size posteriorly; inframaxillary plates somewhat smaller than the posterior sublabials; no enlarged pointed gular scales; one row of pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back with numerous spinous scales; tail of ordinary length, similar to the body, with but few spines along the margin.

Habitat.—Plateau of Mexico.

This species is very easily separated from its nearest allies, *Douglassi* and *orbicularis*, by the character of the occipital spines. In the two latter these spines are directed nearly horizontally backward, while in the present species they project nearly vertically upward.

3. **Phrynosoma orbicularis.**

Lacertus orbicularis Hernandez, Nov. Plant. Anim. Min. Mex., xvi, 1651, p. 327, fig; Linnæus, Syst. Nat., 1789, p. 1061; Cuvier, Regn. Anim., ii, 1817, p. 35; *Id.*, 2d ed., ii, 1819, p. 37.

Agama orbicularis Daudin, Hist. Nat. Rept., iii, 1805, p. 406; Voigt, Uebers. Thierr. Cuv., ii, 1831, p. 54.

Phrynosoma orbiculare Wiegmann, in Oken., Isis, xxi, 1828, p. 367; Wagler, Naturl. Syst. Amph., 1830, p. 146; Gray, Griff. Anim. King., ix, 1831, p. 45; Wagler, Descr. and Icon. Amph., 1833, pl. xxiii, figs. 1 and 2: Schinz, Naturg. und Abild. der Rept., 1833, p. 88, pl. xxvii, fig. 2; Gravenhorst, Act. Acad. Cæs. Leop. Carol. Nat. Cur., xvi, pt. ii, 1833, p. 912, pl. lxiii; Wiegmann, Herp. Mex., 1834, p. 53; Dumeril & Bibron, Erpet. gener., iv, 1837, p. 321; Gray, Cat. Liz. Brit. Mus., 1845, p. 228; Aug. Dumeril, Cat. Meth. Coll. Rep. Mus. Paris, 1851, p. 78; Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 359; Sumichrast, Ann. and Mag. Nat. Hist., xiii, 1864, p. 507; Peters, Berlin Monatsb., 1869, p. 875; Müller, Verh. Natur. Gesell., Basel, 1878, p. 634; Weidersheim, Zool. Anz., i, 1878, p. 105.

Phrynosoma Wiegmanni Gray, Beechey's Voy. Pacif. Zool., 1839, p. 96.

Tapaya orbicularis Girard, Herp. U. S. Expl. Exped., 1858, p. 394; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 221, pl. xi, fig. 1.

Tapaya orbicularis, var. *Cortezi* Dumeril & Bocourt, Miss. Sci. au Mex. et Amer. Cent. Rept., 1870, p. 223, pl. xi, fig. 2.

Tapaya orbicularis, var. *Dugesi* Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 224, pl. xi, fig. 3.

Head as broad as long; cephalic spines moderately developed; occipital spines equal to, or a little more prolonged than, the longest of the temporals, posteriorly; sublabial plates very small; a large conical scale at the angle of the mouth; infra-maxillary plates small, equal in size to the posterior sublabials; one row of pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back spinous; tail of ordinary length, similar to the body, and sparsely fringed with conical scales.

Habitat.—The plateaus of Mexico.

4. Phrynosoma coronatum.

Phrynosoma coronatum Blainville, Nouv. Ann. Hist. Nat., iv, 1835, p. 284, pl. xxv, fig. 1 *a* and 6 *c*; Dumeril & Bibron, Erpet. gener., iv, 1837, p. 318; Holbrook, N. A. Herp., ii, 1842, p. 97, pl. xiii; Dekay, Zool. New York, iii, 1842, p. 31; Aug. Dumeril, Cat. Meth. Coll. Rept. Mus. Paris, 1851, p. 78; Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 360, pl. viii, figs. 7-12; Hallowell, Sitgreaves' Exped. Zuni and Colorado Riv., 1853, p. 122; Sanders, Proc. Zool. Soc. Lond., 1874, p. 71-78 (Myology); Cope, Check List of N. A. Batrach. and Rept., 1875, p. 50; Lockington, Am. Nat., xiv, 1880, p. 295.

Phrynosoma Blainvillei Gray, Beechey's Voy. Pacif. Zool., 1839, p. 96. pl. xxix, fig. 1; Gray, Cat. Liz. Brit. Mus., 1845, p. 228; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of 100 Meridian, v, 1875, p. 582.

Batrachosoma coronatum Fitzinger, Syst. Rept., i, 1843, p. 79; Girard, Herp. U. S. Expl. Exped., 1858, p. 400, pl. xx, figs. 10–13; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., 1870, p. 239, pl. xii, fig. 10.

Head large; nostrils lateral; cephalic spines strongly developed; occipital spines separated from each other by a single plate or small spine, directed horizontally backward, beyond the longest temporals; sublabial plates small; a large flattened scale at the angle of the mouth; inframaxillary plates beneath it very small, the others large and sharp-edged; three or four rows of enlarged pointed gular scales upon each side of, and separated by, the median line; two rows of pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back spinous; tail of ordinary length, similar to the body, fringed with conical spines.

Habitat.—Oregon and California.

In *coronatum* the plate or scale that separates the two occipital spines shows intermediate gradations between a nearly flattened and a tubercular and even spiny surface. Therefore, the possession of a flattened scale by a specimen, which was the leading character upon which *Blainvillei* was established, loses its importance and necessitates its incorporation with the species under consideration.

5. **Phrynosoma asio.**

Phrynosoma asio Cope, Proc. Acad. Nat. Sci. Phila., 1864, p. 178; Sumichrast, Bibl. Univers. et Rev. Suisse, 1873, p. 258; Sumichrast, Bull. Soc. Zool. Fr., 1880, p. 177.

Phrynosoma spinimentum Peters, Berlin Monatsb., 1873, p. 742.

Batrachosoma asio Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., 1870, p. 241, pl. xvii, fig. 9.

Head large; nostrils lateral; cephalic spines well developed; occipital spines vertical, separated from each other by four or five small plates; temporal spines separated from the occipitals, and directed horizontally backward; sublabials small; inframaxillary plates increasing in size posteriorly; three or four rows of enlarged pointed subgular scales on each side of, and separated by, the median line; two rows of pyramidal scales at the periphery of the abdomen; abdominal scales carinated; back

spinous; tail of medium length, similar to the body, and margined with conical scales.

Habitat.—Tehuantepec, Mexico.

This large and beautiful species is most nearly allied to *coronatum*, from which it is separated by the character of the cephalic spines, and also that of the abdominal scales. It is also closely related to the succeeding species, differing, however, in the position of the nostrils, and in the number and position of the rows of enlarged gular scales.

6. **Phrynosoma cornutum.**

Agama cornuta Harlan, Journal Acad. Nat. Sci. Phila., iv, 1825, p. 299, pl. xx.

Lacerta cornuta Cuv., Regn. Anim., 2d edit., ii, 1819, p. 37.

Phrynosoma cornutum Gray, Griff. Anim. King., ix, 1831, p. 45; Holbrook, N. Am. Herp., ii, 1842, p. 87, pl. xi; Dekay, Zool. New York, iii, 1842, p. 31; Gray, Cat. Liz. Brit. Mus., 1845, p. 229; Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 360, pl. viii, figs. 1–6; Blanchard, Organ. Regn. Anim., 1852, pt. v, pl. xii; Hallowell, Sitgreaves' Exped. Zuni and Col. Rivers, 1853, p. 119; Girard, Herp. U. S. Expl. Exped., 1858, p. 403, pl. xxi, figs. 6–9; Baird, U. S. and Mex. Bound. Surv., pt. ii, 1859, p. 9; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., Rept., 1870, p. 236, pl. xii, fig. 9; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of 100th Meridian, v, 1875, p. 579; Müller, Verh. Nat. Gesell., Basel, 1878, p. 634; Cope, Proc. Am. Phil. Soc., 1879, p. 261; Cope, Bull. U. S. Nat. Mus., No. 17, 1880, p. 17.

Phrynosoma Harlani Wiegmann, Herp. Mex., i, 1834, p. 54; Dumeril & Bibron, Erpet. gener., iv, 1837, p. 314; Spring & Lacordaire, Bull. Acad. Roy. Brussels, 1842, pt. ii, p. 192, fig. 2; Aug. Dumeril, Cat. Meth. Coll. Rept. Mus. Paris, 1851, p. 28.

Tropidogaster cornutus Fitzinger, Sys. Rept., i, 1843, p. 79.

Phrynosoma planiceps Hallowell, Proc. Acad. Nat. Sci. Phila., 1852, p. 178; Hallowell, Sitgreaves' Exped. Zuni and Col. Rivers, 1853, p. 124, pl. vii; Dumeril, Arch. Mus. Hist. Nat., viii, 1855, p. 552; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., 1870, p. 238, pl. xii, fig. 11; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of 100th Meridian, v, 1875, p. 579, pl. xxiv, fig. 1; Coues, in the above, p. 593.

Head broad; nostrils anterior, placed within the superciliary ridges; cephalic spines strongly developed; occipital spines long, directed obliquely upward, a smaller spine between the two; posterior inframaxillary plates largest; one row of enlarged pointed gular scales on each side, distant from the median line; two rows

of pyramidal scales at the periphery of the abdomen; abdominal scales carinated, occasionally smooth or nearly so; back with several rows of spiny scales; tail of ordinary length, similar to the body, and fringed with conical scales.

***Habitat.*—Kansas, Indian Territory, Texas, and New Mexico. Possibly from Arkansas and Louisiana.**

The only difference between *cornutum* and the supposed species *planiceps*, was in the character of the abdominal scales, the former being carinated, and the latter smooth. Prof. Cope, however, after examining numbers of specimens, finds that the above forms grade into each other, and, consequently, considers them but one species.

7. Phrynosoma regale.

***Phrynosoma regale* Girard, Herp. U. S. Expl. Exped., 1858, p. 406; Baird, U. S. and Mex. Bound. Surv., 1859, pt. ii, p. 9, pl. xxviii, fig. 1–8; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 310; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 235, pl. xii, fig. 12; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of the 100th Meridian, v, 1875, p. 578; Coues, in the above work, p. 598; Müller, Verh. Nat. Gesell., Basel, 1878, p. 634; Lockington, Am. Nat., 1880, p. 295.**

"*Phrynosoma solaris* Gray, Cat. Liz. Brit. Mus., 1845, p. 229?"

Head large; nostrils anterior; cephalic spines strongly developed, directed backwards; the longest two of the temporals being in the same plane as, and touching, the occipitals, all four being subequal; no plate or scale separating the occipital spines; two rows of enlarged pointed gular scales, one on each side of, and distant from, the median line; last inframaxillary plate smaller than the preceding; two rows of pyramidal scales at the periphery of the abdomen, lower one very small; abdominal scales carinated; back spinous; tail of medium length, similar to the body, and fringed with conical scales.

Habitat.—Valleys of the Gila and Colorado Rivers.

8. Phrynosoma taurus.

Phrynosoma taurus Dugès MSS., 1868; Dugès, Cat. Vert. Mex., 1869; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 234, pl. xii, fig. 8; Dugès, La Naturaleza, ii, 1871–73, p. 302, fig.

Head broad; nostrils anterior; occipital spines small and conical; temporals strongly developed, conical, projecting very much

farther posteriorly than the occipitals; inframaxillary plates nearly equal; one row of enlarged pointed gular scales upon each side of, and distant from, the median line; a single row of pyramidal scales at the periphery of the abdomen; abdominal scales carinated; back spinous; tail very short, about as long as the femur, and with very few conical scales along the margins.

Habitat.—Puebla, Southern Mexico.

9. Phrynosoma Braconnieri.

Phrynosoma Braconnieri Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 233, pl. xii, fig. 7.

Head as broad as long; nostrils anterior; cephalic spines of medium size; occipital spines somewhat less prolonged posteriorly than the longest of the temporals; four or five temporal spines upon each side; one row of enlarged pointed gular scales upon each side of, and distant from, the median line; inframaxillary plates nearly equal; a single row of pyramidal scales at the periphery of the abdomen; abdominal scales carinated; tail very short, little more than half as long as the femur.

Habitat.—Oaxaca, Southern Mexico.

10. Phrynosoma platyrhinos.

Phrynosoma platyrhinos Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 361, pl. vii, fig. 1–5; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 302; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 232; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of the 100th Meridian, v, 1875, p. 577; Coues, in the above work, p. 594.

Doliosaurus platyrhinos Girard, Herp. U. S. Expl. Exped., 1858, p. 409; Baird, P. R. R. Rept., Gunnison & Beckwith's Route, Rept., 1859, p. 18.

Head small; nostrils anterior; cephalic spines of medium size; occipital spines produced further than the longest of the temporals, posteriorly; sublabial plates nearly equal; inframaxillary plates becoming larger posteriorly; one row of enlarged gular scales on each side of, and distant from, the median line; one row of pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back with several rows of spinous scales; tail of medium length, fringed with conical scales.

Habitat.—Utah, Nevada, New Mexico, Arizona and California.

11. Phrynosoma modestum.

Phrynosoma modestum Girard, Stans. Expl. Vall. Gt. Salt Lake, 1852, p. 361, pl. vi, fig. 4–8; Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. [illegible]; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent., Rept., 1870, p. 229; Cope, Check List N. A. Batrach. and Rept., 1875, p. 49; Yarrow, U. S. Geol. Surv. west of 100th Meridian, v, 1875, p. 577; Coues, in the above work, p. 594.

Doliosaurus modestus Girard, Herp. U. S. Expl. Exped., 1858, p. [illegible]; Baird, U. S. and Mex. Bound. Surv., ii, pt. ii, 1859, p. 10; Baird, P. R. R. Rept., x, 1859, Whipple's Route, Rept., p. 38.

Head broader than long; nostrils anterior; cephalic spines small; occipital spines extending as far as the longest of the temporals, posteriorly; auricular aperture sometimes wanting on one or both sides, but when present, small and granular; sublabial plates small and nearly equal; inframaxillary plates broad and pointed; gular scales next to the inframaxillary plates slightly larger than the others; no pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back nearly smooth, devoid of conical scales; tail nearly equal in length to the body, a few conical scales along the basal margin.

Habitat.—Western Texas, Utah, New Mexico and Arizona.

12. Phrynosoma Maccalli.

Anota Maccalli Hallowell, Proc. Acad. Nat. Sci. Phila., 1852, p. 182; Hallowell, Sitgreaves' Exped. Zuni and Col. Rivers, 1853, p. 127, pl. x, figs. 1, 2; Dumeril & Bocourt, Miss. Sci. au Mex. et Am. Cent. Rept., 1870, p. 230.

Doliosaurus Maccalli Girard, Herp. U. S. Expl. Exped., 1858, p. 406; Baird, U. S. and Mex. Bound. Surv., ii, pt. ii, 1859, p. 9, pl. xxviii, figs. 4–6.

Phrynosoma Maccalli Cope, Proc. Acad. Nat. Sci. Phila., 1866, p. 310; Cope, Check List N. A. Batrach. & Rept., 1875, p. 49; Coues, U. S. Geol. Surv. west of 100th Meridian, v, 1875, p. 593.

Head small; snout truncated; nostrils anterior; cephalic spines long, strongly developed; occipital spines slightly recurved; middle inframaxillary spines broadest and longest; one row of enlarged gular scales upon each side of, and distant from, the median line; auricular apertures always wanting; no pyramidal scales at the periphery of the abdomen; abdominal scales smooth; back smooth as in *modestum;* tail as long as the body, margined with conical scales.

Habitat.—Deserts of the Gila and Colorada Rivers.

A REVIEW OF THE AMERICAN GENERA AND SPECIES OF MULLIDÆ.

BY EDWARD A. HALL AND J. Z. A. McCAUGHAN.

In the present paper we have attempted to collect the synonymy of all the American genera and species of the family of Mullidæ. All the specimens examined by us belong to the Museum of the Indiana University.

Analysis of American Genera of Mullidæ.

a. Teeth on lower jaw, vomer and palatines; upper jaw toothless; caudal lobes equal. Vertebræ 9 + 14; the nasal bone, which forms a downward hook over maxillary, strongly developed; interorbital space flat and wide; opercle without spine. D. VII–I, 8; A. II, 6. MULLUS. 1.

aa. Teeth on both jaws; vomer and palatines toothless. Vertebræ 9 + 14; the nasal bone, which forms a downward hook over the maxillary, moderately developed; interorbital space concave and narrow; opercle ending in a single spine. UPENEUS. 2.

1. MULLUS.

Mullus Linnæus, Syst. Nat., 1758, ed. 10, 299 (*barbatus*; *surmuletus*).

The species of this genus, two or three in number, are very closely related. They are chiefly confined to the waters of Europe.

Analysis of Species of Mullus.

a. Depth less than 4 in length; maxillary scarcely reaching front of orbit; eye much larger than in *M. surmuletus*, less than 5 in head; barbels scarcely reaching to lower angle of preopercle, more than $1\frac{1}{3}$ in head. Scales more deciduous than in *M. surmuletus*. (*Vinciguerra*.) *barbatus*.[1]

[1] For purposes of comparison we insert the characters of this European species as given by Vinciguerra. We have examined no specimens of it. The descriptions given by Günther and others, of *M. surmuletus* and *M. barbatus*, are said to show a confusion of the two forms.

aa. Length of head greater than depth of body, $3\frac{1}{4}$ in length of body; depth 4 in length; snout $7\frac{1}{3}$ in length of body; maxillary not quite reaching the vertical from front of eye; eye 5 in head; interorbital space $12\frac{1}{3}$ in length of body; barbels reaching to a point half-way between angle of preopercle and extremity of opercle, $1\frac{1}{3}$ in head. Sides of body with three yellow longitudinal stripes; first dorsal barred with light and black. ***surmuletus.*** **1.**

aaa. Length of head about equal to depth of body, about $3\frac{4}{5}$ in length of body; snout $7\frac{4}{10}$ in length of body; maxillary just reaching vertical from front of eye; eye 4 in head; interorbital space $14\frac{3}{4}$ in length of body; barbels reaching to extremity of opercle, $1\frac{1}{3}$ in head; scales in lateral line 32. Sides of body with two yellow longitudinal stripes; first dorsal with an orange band at base and a yellow one higher up; second dorsal mottled with scarlet and pale; no black on dorsals. ***surmuletus auratus.*** **1 (b).**

1. Mullus surmuletus.

(a.) Var. surmuletus.

Trigla capite glabro, lineis utrinque quatuor, luteis longitudinalibus parallelis Artedi, Ichthyol., 1738, 43 (Mediterranean Sea; Ocean by Cornwall).

Mullus surmuletus Linnæus, Syst. Nat., 1758, ed. 10, 300 (Mediterranean); Linnæus, Syst. Nat., 1766, ed. 12, 496 (Mediterranean); Brunich, Ichthyol. Massiliensis, 1768, 72 (Marseilles); Pennant, "Brit. Zool., iii, 1769, 268, pl. 54"; Bloch, Ichthyologia, Taf. 57, 1785; Bonnaterre, "Ichthyol, 1790, 144, pl. 59, fig. 233"; Linnæus, "Fauna, Suec. ed. Retz, 1800, 341"; Shaw, "Brit. Zool., iv, 1800, 1819, 613, pl. 88"; Bloch & Schneider, Syst. Ichthyol., 1801, 77, Taf. 18; Donovan, "Brit. Fish., i, 1801, pl. 12"; Turton, "Brit. Zool., 1807, 102"; Risso, Ichthyol. de Nice, 1810, 215 (Nice); Martens, "Reise nach Venedig, ii, 1824, 427" (Venice); Fleming, "Brit. An., 1828, 216"; Cuvier & Valenciennes, Hist. Nat. Poiss, iii, 1829, 433 (Marseilles; Ivica; Nice; Naples); Cuvier, Règne Animal, ed. ii, 1829.

Mullus surmuletus Lacépède, Poiss., v, 1803, 75 (Mediterranean, Baltic, Atlantic Ocean); Jenyns, "Manual Brit. Vert., 1835, 337"; Yarrell, "Brit. Fishes, i, 1841, 31"; Guichenot, Explor. Sci. Alger. Poiss., 1850, 38 (Algiers); White, "Cat. Brit. Fish., 1851, 14"; Thompson, "Nat. Hist. Ireland, iv, 1856, 70" (Ireland); Günther, Cat. Fish. Brit. Mus., i, 1859, 401 (Brixham; British Channel; Madeira, Mediterranean; Dalmatia); Couch, "Fish. Brit. Isles, i, 1862, 206, pl.

47"; Collet, Norges Fiske, 1875, 17 (Christianafjord; Lindesnaes; Bergen); Bean, Proc. U. S. Nat. Mus., 1879, 26 (Europe); Vinciguerra, Risult. Ittiol. del Violante, 1883, 41 (Dalmazia; Marcova, Melida; Curzola; Lissa; Lagosta and Cazza).

Mullus barbatus De la Roche, "Ann. Mus. xiii, 1809, 306"; Gronow, Cat. Fish. 1854, 108; Steindachner, Uebersicht Meeresfische an Küsten Spaniens und Portugals, 1867, 83 (Cadiz; Lisbon; Gibraltar; Teneriffe); Botteri, Cat. Pisci di Lesina, 1873, 60 (Lesina).

Mullus barbatus surmuletus Day, Fishes of Great Brit., 1880, 22, pl. 8, fig. 2 (Mevagissey).

Mullus dubius Malm, "Ofversigt of Kongl. Vet. Akad. Forhandl., 1852, 224" (Sweden).

(*b.*) **Var. auratus.**

Mullus barbatus auratus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 280 (Pensacola); Jordan & Gilbert, Syn. Fish. N. A., 1882, 931 (Pensacola; Wood's Holl).

Mullus auratus Jordan Proc. U. S. Nat. Mus., 1884, 39 (Pensacola).

Habitat.—Var. *surmuletus*, on all southern and western coasts of Europe, from Sweden to Africa; the most common species in most parts of Europe. Var. *auratus*, eastern coast of America, Wood's Holl to Pensacola.

This form called *auratus*, has been occasionally taken on our Atlantic and Gulf coasts, but it is evidently rare. The single specimen examined by us came from deep water at Pensacola. It seems to us to be a variety of *M. surmuletus* rather than a distinct species, and it is certainly nearer *M. surmuletus* than *M. barbatus*, as the latter is described.

Many European writers have denied the distinctness of *M. surmuletus* and *M. barbatus*. The following account of the two, translated from Vinciguerra's Risultati Ittiologici del Crociere del Violante, seems to give a final answer to the question as to the difference between these two species.

"No one of the Mediterranean ichthyologists has yet been willing to accept the fusion of these two forms, an opinion which I regard as really incorrect, and caused by the scarcity of *M. barbatus* in the waters of the Atlantic and Baltic. I have been able to verify, on an extensive series of examples, that in *barbatus*, as in *surmuletus*, there exist two forms; the one with the profile oblique, the other with the profile rectilinear. These probably represent the two sexes, and those who wish to take as

a differential character the form of the head are thus easily led into error. The real differences which exist between *surmuletus* and *barbatus*, besides that of coloration, are the following: In *M. surmuletus*, the diameter of the eye is much smaller, and the barbels are more robust and longer, reaching beyond the lower angle of the opercle (in *barbatus* they scarcely reach this point), and the body is notably deeper. To these characters may be added the greater adherence of the scales in *surmuletus*, while in *barbatus* these are readily deciduous, and only in extraordinary cases is a specimen found possessing a single scale. In every market on the coast of the Mediterranean the fishermen distinguish between the two species by different names, according to their coloration, relative length of barbels and the place where they live by preference; inasmuch as *surmuletus* is found most readily in rocky places (and hence the common name 'Triglia di Scoglia'), and *barbatus* is found in muddy places (and hence the common name 'Triglia di Fango')."

2. UPENEUS.

Upeneus Cuvier, Règne Animal, ed. 2, 1829 (*vittatus; russelli; bifasciatus; trifasciatus*).

Hypeneus Agassiz, Nom. Zool., Index Universalis, 1846, 190 (amended orthography).

Mulloides Bleeker, "Ceram II, 697, 1852–65 (*flavolineatus*)."

Pseudupeneus Bleeker, Poiss. Côte de Guinée, 1862, 56 (*prayensis*).

Parupeneus Bleeker, Notice sur le *Parupeneus bifasciatus* de l'Ile de la Reunion, 1867, 345 (*bifasciatus*).

Mullhypeneus Poey, Syn., 1868, 307 (*maculatus*).

We include under the head of *Upeneus* all the *Mullidæ* having teeth on both jaws and none on the vomer. The variations in the size and number of the teeth seem to us of minor importance.

Analysis of Species of Upeneus.

a. Teeth on under jaw uniserial, on upper jaw uniserial or occasionally irregularly biserial with the outer teeth turned outward; all the teeth coarse and distinct; maxillary $2\frac{1}{4}$ in head, not reaching vertical from front of eye by one-half of its length; barbels extending to a point half-way between the vertical of preopercle and extremity of opercular spine, $1\frac{1}{3}$ in length of head; eye 4 in head; scales in lateral line

31; depth, 4 in length; dorsal VIII–I, 8; anal, II, 6. Color in spirits, steel-blue above, descending on sides in three blotches; one above point of opercular spine, sometimes extending on opercle; one under each dorsal fin. Under-parts of body pale. *maculatus*. 2.

aa. Teeth of upper jaw uniserial, of lower biserial; teeth rather strong, weaker than in *U. grandisquamis;* barbels extending nearly to vertical of preopercle; eye large, 3 in head; scales in lateral line, 37; depth about 5⅝ in total length, 4⅓ in length. Dorsal VII–I, 7; anal I, 5 or 6. Color, bright pink or rose, with broad red band extending from eye to caudal and suffusing caudal (*Gill*). *dentatus*. 3

aaa. Teeth on both jaws in more than one series.

b. Teeth on anterior part of jaws in two irregular series; lateral teeth on jaws in a single series; all the teeth obtusely conical and distinct from each other; teeth on upper jaw turned inwards; barbels extending to vertical of preopercle, 1½ in length of head; eye 3⅓ in length of head; scales in lateral line 39; depth 4 in length. Dorsal VIII–I, 8; anal II, 6. "Color in life, flesh-color above, sides silvery, tinged with yellow below; a bright yellow band from eye to base of caudal; a whitish streak above and below this; another above lateral line; both dorsals and caudals bright yellow." *Martinicus*. 4.

bb. Teeth on anterior part of jaws in two series; the outer series of the upper jaw being formed by very obtuse and partly confluent teeth. Barbels extending to vertical from root of pectoral fins; eye 4 in head; scales in lateral line 32; dorsal VIII–I, 8; anal I, 6. Color light greenish brown above, rose-color below lateral line; scales with indistinct pearly spot at centre; black blotch on lateral line behind spinous dorsal; a smaller, sometimes indistinct black spot behind orbit; dorsal fins with spots the color of the back; other fins immaculate. *grandisquamis*. 5.

2. Upeneus maculatus.

Mullus maculatus Bloch, "Ichthyol. about 1790, Taf. 348 (Brazil);" Lacépède, Poiss., iii, 1798–1803, 403 (West Indies; Brazil).

Mullus surmuletus var. *maculatus* Bloch & Schneider, Systema Ichthyol., 1801, 78 (Brazil).

Upeneus maculatus Cuvier & Valenciennes, Hist. Nat. Poiss., iii, 1829, 478 (Martinique; Brazil); Storer, "Syn. Fish. N. A., 1846, 48;" Poey, Mem. Pisc. Cuba, i, 1851, 223 (Martinique; Brazil); Castelnau, "Anim. nouv. ou rares Amer. Sud, 1850-61, 6 (South America); Günther, Cat. Fish. Brit. Mus., i, 1859, 408 (Atlantic coasts of Tropical America; Jamaica); Cope, Trans. Amer. Phil. Soc., 1870, 471 (St. Croix); Jordan & Gilbert, Syn. Fish. N. A., 1882, 565; Jordan, Proc. U. S. Nat. Mus., 1884, 129 (Key West).

Mullhypeneus maculatus Poey, Syn., 1868, 307 (Cuba).

Mullhypeneus maculatus Poey, Enum. Pisc. Cuba, 1875, 34 (Havana; Jamaica).

Hypeneus maculatus Goode, Bull. U. S. Nat. Mus., v, 1876, 49 (no specimen).

Upeneus punctatus Cuvier & Valenciennes, Hist. Nat. Poiss., iii, 1829, 482 (Mexico); Kner, Novara Fische, 1857-59, 71 (Rio Janeiro); Cope, Trans. Amer. Phil. Soc., 1870, 471 (St. Kitts).

Habitat.—Atlantic coasts of Tropical America, from Key West to Rio Janeiro.

The specimens of this species examined by us are from Key West and Havana.

3. Upeneus dentatus.

Upeneus dentatus Gill, Proc. Acad. Nat Sci. Phila., 1862, 256 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 363 (Cape San Lucas).

Habitat.—Pacific coast of Tropical America; Lower California.

This species is known to us only from the description of Gill, and the notes of Jordan and Gilbert on Gill's original types.

4. Upeneus martinicus.

Upeneus martinicus Cuvier & Valenciennes, Hist. Nat. Poiss., iii, 1829, 483 (Martinique).

Upeneus balteatus Cuvier & Valenciennes, Hist., Nat. Poiss., iii, 1829, 484 (Cuba); Poey, Mem. Cuba, i, 1851, 224 (Cuba); Jordan, Proc. U. S. Nat. Mus., 1884, 129 (Key West).

Mulloides balteatus Cope, Trans. Amer. Phil. Soc., 1870, 471 (St. Kitts).

Upeneus flavovittatus Poey, Mem. Cuba, i, 1851, 225 (Cuba).

Mulloides flavovittatus Günther, Cat. Fish. Brit. Mus., i, 1859, 403 (Caribbean Sea; Jamaica; Cuba).

Upeneus parvus Poey, Mem. Cuba, i, 1859, 225 (Cuba).

The specimens of this species examined by us are from Key West and Havana. Poey has identified his *flavovittatus* and *parvus* with the *balteatus* of Cuvier and Valenciennes. There seems to be little room for doubt that the scanty description of *martinicus* refers to this species also.

5. Upeneus grandisquamis.

Upeneus grandisquamis Gill, Proc. Acad. Nat. Sci. Phila., 1863, 168 (West coast Central America); Günther, Fish. Central America, 1864, 420 (copied from Gill); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 626 (no description); Steindachner, Ichthy. Beiträge, iv, 1875, 6 (Panama).

Upeneus tetraspilus Günther, "Proc. Zool. Soc., 1864, 148;" Günther, Fish. Central America, 1864, 420, Pl. 66, fig. 1 (Panama).

Habitat.—Pacific coast of Tropical America; Panama.

This species is known to us only from the descriptions of Gill, Günther, and Steindachner. Professor Jordan tells us that the *Upeneus tetraspilus* of Günther is certainly the same as the *Upeneus grandisquamis* of Gill.

[We regret to announce that while this paper was going through the press, one of the authors, Mr. Edward Allen Hall, was drowned in Salt Creek, about eleven miles from Bloomington, Ind., on May 22, 1885. He was born at Rushville, Ind., January 9, 1864, and had, during his course of study at the State University of Indiana, proven himself to be an energetic and faithful student.—E. J. N.]

May 26.

Mr. John H. Redfield in the chair.

Forty-one persons present.

The following papers were presented for publication:—

"Marginal Kames," by H. Carvill Lewis.

"Description of New Species of Lepidoptera," by Herman Strecker.

The death of Jacob P. Jones, a member, was announced.

Antonio de Gregorio, of Palermo, was elected a correspondent.

June 2.

Mr. Edward Potts in the chair.

Thirty-seven persons present.

The following papers were ordered to be printed:—

MARGINAL KAMES.[1]

BY H. CARVILL LEWIS.

Introduction.—During the course of an investigation, in 1881, of the extreme southern edge of the great ice-sheet in Pennsylvania, as marked by its *terminal moraine*, the writer had an opportunity of studying several phenomena produced by the glacier along the line of its southern terminus; one of the most interesting of which phenomena were certain short hummocky ridges of stratified drift, which, often closely connected with the terminal moraine, appear to belong to a class of surface deposits elsewhere called *Kames*.

The kames of Scotland, the *Eskers* of Ireland, and the *Asar*, or *osars*, of Scandinavia, all closely related, if not identical, deposits, find an analogue in the ridges of stratified drift which have been described by a number of geologists as occurring in northeastern America, including Canada.

They may be described as narrow ridges of stratified, water-worn, generally sandy drift, which, sometimes forming a series of tortuous and reticulated hills, sometimes a nearly regular straight ridge, and often forming knob-like conical hills ("hummocks"), alternating with similar conical depressions ("kettle-holes"), generally lie along valleys or depressions, and have a general downward slope from a higher to a lower level.

These gravel ridges are generally quite steep—as steep often as the nature of the material will allow. This steepness is quite striking to a geologist accustomed to the gentle slopes of the gravel formations in the non-glaciated portion of this country, and at once suggests the *recency* of their origin.

The internal structure of kames is in general anticlinal. "Flow-and-plunge" structure, and oblique lamination, the evidence of rapid fluviatile action, is often seen in their interior; and as a rule the material is finest in the interior, and most coarse on the exterior portions of the kame.

Wherever along the course of the terminal moraine the writer has had an opportunity of examining recently made transverse sections of these drift ridges, he has found clean water-worn sand within,

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[1] Read before the British Association for the Advancement of Science, Montreal, August 29, 1884.

showing distinct torrential action, and a coarse gravel on the outside. Sometimes, but rarely, large boulders lie on top of the kames. The writer has never observed large boulders within them. The material is generally small, and well water-worn and rounded, showing no glacial scratches on its pebbles, and for the most part is of local origin.

The contours of these kames in their "hummocky" appearance, are very like those of moraines. Indeed, it is often impossible to distinguish kames from moraines by external features alone. When, however, we take into consideration their structure and their position, they cannot readily be confounded. Their distinguishing characters are (1) their internal structure, kames being distinguished by an absence of till and glaciated pebbles, and by stratified, generally anticlinal, structure—all of these characters being very different from the unstratified pell-mell character of moraines; (2) their geographical position and the influence of the surrounding topography upon them. Topography has practically no influence on the moraine of the great glacier. The terminal moraine on the Pocono plateau closely resembles that in Cherry Valley, 1000 feet below it; and the moraine at the height of 2500 feet, in central Pennsylvania, cannot be distinguished from that in New Jersey, at the sea-level. The moraine may lie on the downward slope of a hill, as at Fishing Creek, Columbia Co.; may form a dam across a creek, as at Cole's Mills, or it may stretch transversely across a mountain ridge such as the Kittatinny Mountain.[1]

On the other hand, kames as a rule depend directly upon topography. While they do not always coincide with the present drainage systems, they extend from higher to lower levels. They follow valleys generally along the central line, but sometimes, indeed, rising over considerable elevations. Where the valleys are distinct and sharply defined by high ridges on either side, the kames are confined to them, and follow more or less closely the modern water-courses; but where, as in southeastern Massachusetts, the valleys are not well marked, and there is no defining wall, the country being nearly level or rolling, and there being no mountain ranges, kames often cross where there are now no

[1] This independence of the terminal moraine as regards topography, is prominently brought out in the detailed description of it given by the writer in Report Z, Second Geological Survey of Pennsylvania.

water-courses, even crossing rivers, as may be seen on the Merrimac at Lawrence, which is said to be crossed at right-angles by a kame.[1] In no sense, however, can kames be regarded as the work of rivers merely. For, as Prof. Stone has shown so clearly in Maine, they sometimes rise out of a valley and pass through a gap in the hillside or cross a ridge perhaps 150 feet high, to low grounds beyond. Prof. Stone has in several cases followed them *up-hill* for a short distance.

Such facts may best be explained by the supposition that the stream of water which formed them must have either been enclosed within high walls of ice, or have flowed in a subglacial tunnel.

Literature.—A large number of kames, occurring under various conditions, have been observed in different portions of the glaciated area of North America. None occur south of that area.

As long ago as 1842, Dr. Edward Hitchcock described a series of gravel ridges which pass through Andover, Mass., and which is known locally as "Indian Ridge." At that time he regarded this ridge, composed, as he well described it, "of a collection of tortuous ridges and rounded even conical hills with corresponding depressions between them,"[2] as a species of moraine. These have been more recently studied in detail by Prof. G. F. Wright,[3] who has shown that they form part of a chain of such ridges, many miles in length, running from Franklin, N. H., to Malden on the ocean, and are true kames.

The most complete studies of kames in this country are those made by Prof. Geo. H. Stone,[4] who has mapped some thirty-one linear systems of kames in the State of Maine, all running from the high interior of the State southeastward toward the sea. He describes them as meandering like rivers in their course from the mountains oceanward. They start sometimes at elevations as high as 1600 feet above the ocean, they freely cross low transverse hills 100 feet high, but not 200 feet high, and they have a strong inclination to keep within straight lines, notwithstanding minor obstacles. These ancient gravel streams were not so easily turned from their course as streams of to-day. When once in a valley

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[1] Wright, Proc. Bost. Soc. Nat. Hist., xix, 47.

[2] Trans. Am. Assn. Geol. and Nat., 1841–2, p. 191.

[3] Proc. Bost. Soc. Nat. Hist., Dec., 1876.

[4] Kames of Maine. Proc. Bost. Soc. Nat. Hist., xx, 430, 1880.

coinciding with the main direction of the kame, the latter is apt to keep in it. Prof. Stone states that these long ridges are homologous with the Scandinavian Osars, rather than with the short ridges classed as kames.

In other parts of New England, kames have been described by several authors. In New Hampshire, Prof. C. H. Hitchcock and Mr. Warren Upham have made noteworthy contributions to this subject. In vol. iii of the New Hampshire Geological Survey, Mr. Upham has contributed a valuable chapter on surface deposits, among which the most important are the numerous kames. One of these, described by Mr. Upham as occupying the valley of the Connecticut River, has subsequently been studied by Prof. Dana, who believes [1] that it is merely a portion of the terrace formation in that valley, and that the name of kame should not properly be applied to it. Prof. Hitchcock,[2] however, has subsequently examined a critical locality in the Connecticut Valley, and finds the arched kame-gravel dipping beneath a horizontal terrace-loam, thus showing the greater age and different origin of the kame, and supporting Mr. Upham's views.

Prof. J. S. Newberry [3] and Prof. N. H. Winchell have described kames in Ohio, where they are known locally as "hog-backs.' Prof. Newberry at that time regarded them as due to the action of breakers and shorewaves at a period when the region was submerged under an inland fresh-water lake. Kames and kame-like ridges have also been described in Michigan and in Minnesota. In Canada, Sir William Dawson [4] has described certain ridges known as "Boar's-backs" and "Horse-backs," which he regards as eskers. One of these, in Cumberland, is a narrow ridge, so level on top that it forms a natural carriage-road for eight miles; another one, in Shelburne County, is a long ridge, also used as a carriage-road; while shorter and more interrupted ridges occur in a number of places. Sir William Dawson remarks that they bear no resemblance to glacial moraines, and believes that they were thrown up by "the surf or marine currents and tides." Prof. T. C. Chamberlin [5] has given an excellent description of kames

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[1] Am. Jour. Sc., xxii, 451, 1881.

[2] Proc. Am. Assn. Adv. Sc., xxxi, 325, 1882.

[3] Geol. Surv. of Ohio, vol. ii, p. 41–47.

[4] Notes on the Post-Pliocene Geol. of Canada, 1872, p. 40.

[5] Hillocks of angular gravel and disturbed stratification. Amer. Jour. Sc., xxvii, 1884, p. 378.

associated with terminal moraines in Wisconsin and elsewhere, and his paper contains a good reference list to the literature of kames. The kames described by him differ from those described in the present paper in being knob-like hills, "simple isolated mounds," or clusters of such mounds, rather than linear ridges, and also in lying transverse to the glacial movement, which is not the case with the Pennsylvania deposits.

Origin of Kames.—The early view of geologists as to the origin of kames, was that they were washed into shape by the waves and currents of the ocean. This was the view held by Dr. Jas. Geikie in the first edition of his "Great Ice Age,"[1] and was formerly advocated by many geologists both in Europe and America. But recent researches have shown that this view is untenable, and in the second edition of Dr. Geikie's book kames are regarded as the work of subglacial rivers.[2]

The researches of American geologists, especially the work in New England of Upham, Wright and Stone, have shown the occurrence of kames in positions out of the reach of oceanic currents. When marine deposits occur, as they do along the border of New England, in the St. Lawrence Valley, and elsewhere, they are seen to be horizontally stratified sands and clays often holding marine fossils, and clearly overlying the kame ridges. The terrace material of flooded rivers is also observed to overlie the kames.

On the other hand, kames are newer than glacial till, and overlie and swing around the drumlins of Massachusetts. These "drumlins," like those described by Kinahan and Close in Ireland,[3] are low oval hills, composed of unstratified glacial till, and are most satisfactorily explained as lenticular ground moraines formed under the ice sheet during its advance. They have been called "lenticular hills." Their longer diameter is generally parallel to the direction of the ice flow, as shown by neighboring striæ, and they appear to be of a mid-glacial age.[4]

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[1] Page 229.

[2] Page 217, etc.

[3] Glaciation of Iar-Connaught, Kinahan and Close, 1872.

[4] For discussion of "lenticular hills," see papers in Proc. Bost. Soc. Nat. Hist., by N. S. Shaler (xiii, 196), and by C. H. Hitchcock (xix, 63), and Geol. Survey of N. H., iii, p. 287; also, an article by W. M. Davis, Science, iv, 419.

Kames, therefore, would appear to be intermediate in age between the time of the deposition of the till or ground moraine and the age of the terraces and marine deposits. Mr. Upham[1] regards them as due to rivers flowing in channels formed upon the surface of the ice near its retreating edge. As the wall of ice on either side disappeared at the final melting of the ice sheet, the gravel and sand remained in long ridges or in mounds. He believes that kames were formed at or near the mouths of these surface streams, extending along the valley as fast as the ice front retreated.

Prof. G. F. Wright[2] believes that in many cases they are due to the sliding down from the surface of the ice of morainic debris accumulated near its end, so that they may represent medial moraines. He shows that they do not lie in channels worn in the till, and that very often they are unstratified, and thinks that the material composing them may have first formed lines upon the top of the ice. But, as Prof. Stone has shown, it is only among the highlands that the material of kames are poorly stratified; as soon as open valleys are reached the materials are worn, rounded and stratified.

Quite recently Prof. T. C. Chamberlin, of the U. S. Geological Survey, in an important paper "On the Terminal Moraine of the Second Glacial Epoch,"[3] proposes to separate kames from "Åsar," regarding kames proper as *tranverse* to the slope of the surface, the course of the valleys and the direction of the drift movement,"[4] while the term åsar is employed to designate long river-like ridges of gravel. Åsar are described as extending "from higher to lower levels, following in general but not in detail the course of the greater valleys and the direction of glacial striation." As stated elsewhere,[5] they are held to be "the products of the drainage system of practically extinct glaciers."

This is practically the view of Professor Stone, and of other recent workers in this field, as it is that of the present writer. *Moraines* are the *product* of the *advance* of the ice-sheet, osars

[1] Geol. of N. H., vol. 3, pp. 14–176.

[2] Proc. Bost. Soc. Nat. Hist., xx, 219.

[3] Third An. Rep. U. S. Geol. Surv., p. 295, etc.

[4] *Loc. cit.*, p. 300.

[5] Amer. Jour. Sc., xxvii, 378.

and kames of its *retreat.* If the distinction between osars and kames be sustained, the deposits described in the present paper might more properly be called "*marginal osars.*" In many characters, however, they are intermediate between osars and kames as defined by Professor Chamberlin.

Kames are shown by the same authority to be composed of material derived from the adjacent till, and of local derivation, and from a study of their topographical situations and other features, the just conclusion is drawn [1] "that these hills could not have been produced by any form of beach action, whether assisted by ice or not," but that "they were formed along the edge of the ice-sheet by numerous marginal streams."

Prof. Chamberlin makes these kames "associates if not constituents of terminal moraines;" and classes them among moraine deposits. He says,[2] "It is my belief that they were due to special aqueous action attending glacial advances in such close relationship that they become distinctive incidental products, and mark the position of halt and retreat, as characteristically as the true moraines of mechanical origin themselves, which they so often overlie and conceal."

He therefore regards certain stratified knob-like hills of gravel in western and central New York State as representing a true terminal moraine of the second glacial epoch, and he has traced such a *kame-moraine* from Chautauqua Lake to the Mohawk and Catskills. These lines of hills he regards as representing the boundary of the great ice sheet at the period of its longest halt. He says that this inner morainic belt is "more massive and pronounced in development than the moraine referred to the older epoch,"[3] and "that its surface is fresher and less subdued by meteoric modification."

Granting that the line of kames so carefully traced out by Professor Chamberlin is correctly interpreted as representing a halt in the retreating ice-sheet, the present writer holds that, on account of their stratified character, such gravel deposits should not be identified with the unstratified masses of glacier-made till which constitute the true terminal moraine. The one is due to

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[1] *Loc. cit.*, p. 387.

[2] Third An. Rep. U. S. Geol. Surv., p. 376.

[3] *Loc. cit.*, p. 346.

water action, the other to ice action. The term *kame-moraine* is, in the opinion of the writer, a more appropriate name for such deposits than terminal moraine, which latter term would then be kept to designate the extreme outer mass of debris pushed out or dropped by the glacier at the time of its farthest extension.

That kames may be associated with the terminal moraine, is a fact which the writer will endeavor still further to demonstrate. But that they are distinct from it in structure, origin, and significance, will, it is believed, be granted after a careful consideration of the facts observed in Pennsylvania.

Marginal Kames in Pennsylvania.—That the terminal moraine separating the glaciated from the non-glaciated district has, throughout the greater part of its course in Pennsylvania (Plate III), an essentially unstratified character, has been sufficiently demonstrated in the author's report describing it.[1]

It has been shown that even where crossing river-valleys its unstratified condition is maintained; as, for example, opposite Belvidere in the Delaware, and at Beach Haven on the Susquehanna, at both of which places it is clearly distinguished from the stratified material lapping up against it. But immediately back of the moraine there occur in many places other stratified deposits, which, although similar in contour to the moraine proper, are worthy of separate consideration.

The class of kames which it is now proposed to describe, have, the writer believes, not heretofore been recognized in their true significance. These are either directly connected and continuous with the terminal moraine in Pennsylvania, or they are in such close proximity to it that they may properly be known as *marginal kames*. This term is given in order to distinguish them from longer kames or osars which may have no relation to the margin of the ice-sheet. None of them are transverse to the motion of the glacier, like a moraine, unless the drainage makes them so, and in this respect they do not answer to the definition of a kame given by Prof. Chamberlin, but have distinct characters of their own. They are all short, from a few hundred feet to a few miles in length, and they all follow the direction of the drainage. They have a general downward slope, and all lead toward a river-valley or other water-course. All those observed are made of water-worn materials, and where sections can be

[1] Report Z, Second Geological Survey of Penna.

obtained show an anticlinal structure within. As already stated, their materials are finer in the interior, and most coarse in the exterior, and sometimes, though rarely, large boulders lie on the surface. The comparative shortness of their courses distinguish them from the long river-like osars. Their origin and significance can best be appreciated after a description of a few of them in detail. The accompanying map gives their general position with regard to the terminal moraine.

There are three kames in Northampton County, Pa., which are especially instructive. The most prominent of these is that which traverses the centre of Mt. Bethel Township in a northeast direction, follows approximately the valley of Jacobus Creek, and ends upon the banks of the Delaware at Portland.[1]

This kame, which has been mistaken for the terminal moraine,[2] is composed of a series of interlacing ridges and hummocks, often enclosing kettle-holes, and formed of stratified sand and water-worn gravel, carrying occasional rounded boulders upon the surface.

The town of Portland is built upon the kame, which here rises 100 or more feet above the river, forming a prominent hill. Some fine railroad cuts, through several ridges of the kame, 2½ miles from Portland, show it to consist of a stratified sand overlaid by a boulder-bearing clay, or till, as though it had been formed by running water *beneath* the ice, which on melting dropped the till. At this place, one mile southeast of Roxborough (Johnsonville P. O.), the kame is composed of a series of reticulated ridges, enclosing typical kettle-holes. One of these, known locally as the devil's kettle, and supposed by some to be an old Indian fort, is a symmetrical oval depression, surrounded by a raised rim, 300 feet long by 200 wide, and 30 deep. Like most kettle-holes, it has its longer axis parallel to the direction of the kame in which it lies. In the same neighborhood, similar rounded shallow depressions, with neither inlet nor outlet, lie upon the very summit of sandy ridges 100 feet above the level of the surrounding country.

These kettle-holes do not appear to be the result of natural erosion, and they are in no way allied to ordinary valleys or ravines, produced by the action of running water. The instruc-

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[1] See Page Plates 8 and 9, in Report Z, pp. 53, 68.

[2] F. Prime, Proc. Amer. Phil. Soc., xviii, 85.

tive fact that a raised rim frequently completely surrounds the kettle-hole, so as to elevate it above the surrounding country, is conclusive against any theory of ordinary erosion. In fact, the comparative *absence of erosion*, is one of the most remarkable facts relating to kames and their kettle-holes.

The kame here described is confined to the valley of Jacobus Creek. The high hills on the south are sprinkled with boulders, but hold no deposits of stratified drift.

The length of the kame is five miles. Its general elevation near Johnsonville is 600 feet above the sea, or 300 feet above the Delaware River at Portland; giving a northeastward slope to the kame of nearly 100 feet to the mile. It seems to have been caused by a stream, probably subglacial, draining *backwards* into the Delaware River at Portland. The direction taken by the stream producing the kame was just contrary to the direction of ice-flow, which was southeast. This kame is a good example of a *backward-draining* marginal kame.

Another locality which throws light on the origin of kames is in Upper Mount Bethel township, close to the base of the Kittatinny Mountain, and about a mile east of the moraine.

Here, on the road to the Fox Gap, a number of small, rounded, hummocky drift hills, and a series of ridges, irregularly interlaced with each other, composed of sandy water-worn drift within, but bearing upon their surface many boulders, form a fine series of small kames. These kames are not straight; they follow a curved line around Offset Knob.

Close to the flank of the mountain they bear south 20° west; somewhat lower and farther from the mountain, they bear south 30° west; still farther down the road, they veer yet more southwest. They seem to represent streams which, descending from the melting ice on the mountain, flowed at first southward, and then westward around Offset Knob, and, after issuing from the end of the glacier, emptied into the deeply flooded valley of Bushkill Creek, in Plainfield township.

Immediately north of these kames, a great accumulation of till and boulders forms a high ridge upon the side of the mountain. Most of the boulders are of Medina sandstone, but occasional boulders of limestone, and of fossiliferous rocks brought from the valley on the other side of the mountain, are found. This accumulation at a higher elevation than the series

of kames represents the portion of the glacier whose melting supplied the kame streams. These small kames represented an outward drainage.

There are two curious little kames immediately south of Ackermanville, in Washington Township, Northampton County, which, though but miniature examples, have all the characters of larger kames, and offer a suggestion as to their origin.

Two small, straight, narrow ridges of stratified drift, 15 feet high and about 100 feet long, may be seen just below the village, running nearly at right-angles to the valley of the west branch of Martin's Creek. Both of these ridges run from the base of a hill west of the creek toward the stream, their direction being south 75° east; and west of each of them there is an opening in the hill, near the summit of which the moraine lies.[1]

Upon examining the structure of these ridges, as exposed by transverse cuts made by the railroad, they are found to be composed of fine stratified sand within and gravel without. The sand shows flow-and-plunge stratification, with a distinct anticlinal structure.

Here again the only satisfactory explanation is that they are due to subglacial streams which drained the melting edge of the glacier on the hillside *backward* into the subglacial valley, now occupied by the west branch of Martin's Creek. They are here at an elevation of 500 feet above the sea and about 190 feet below the edge of the moraine and are beautiful examples of miniature kames. An important point to note is that on placing the eye along the crest of each of these they are seen to be opposite small depressions in the hill on which the moraine rests. They are thus in precisely the position that would be occupied by the natural drainage of the edge of the ice-sheet.

The most interesting of all the kames of Monroe County are the curious conical hills and short ridges of sandy drift which lie along the centre of Cherry Valley, between the moraine and the Delaware River. A remarkable series of conical hills of peculiar and characteristic topography either stand singly, or (more generally) are connected one with another by irregular banks of gravel, to form a series parallel with the valley.

Near the Delaware Water Gap these hills rise often over 200 feet above the river, and often inclose basin-shaped depressions

[1] See sketch-map in Report Z, p. 34.

or kettle-holes. They are most abundant between Stormville and the river. Where the valley widens, just east of Stormville, two sets of kame-like ridges on either side of the valley have the form of a V.

Short *tributary kames*, whose axes are at right-angles to the main kame in the valley, appear opposite ravines or depressions in the hills bordering the valley.

A *buried kame* lies along the north and south valley of Broadhead's Creek, almost completely covered by subsequent deposits of terrace material. The *top* of the kame stands out of the level terrace plain which borders the creek at Stroudsburg and vicinity. A fine section of the buried kame at Stroudsburg shows its anticlinal structure and a *fault* in it caused by settling.

Another most interesting *buried kame* is in the valley of McMichael's Creek, in Hamilton Township, where the top of the kame appears through the sandy terrace plain which covers the valley. The kame runs along the centre of the valley while the creek wanders irregularly through it. The kames are clearly older than the terrace material.

Of the other kames and kame-like ridges of Monroe County, reference only need here be made to certain kames upon the summit of the Pocono plateau, which are of interest in draining *northward;* of these there may be mentioned the steep, sharp ridges of sand near Tompkinsville, Tolyhanna Township, which run toward lower ground northward, thus draining the glacial waters toward the Lehigh. These are immediately back of the terminal moraine.

Again, just west of the Lehigh River, and immediately north of the moraine, there appear kame-like ridges of sand and gravel in small valleys emptying into the Lehigh. These are *parallel to the moraine*, and are so simply because the drainage is here south of east, while the moraine trends to the northwest.

Below Scranton, on the Lackawanna River, and also on the Susquehanna, are long ridges of stratified sandy material, which are quite distinct from the terrace deposits of those rivers, and which appear to be portions of a kame similar to that described by Mr. Upham on the Connecticut River, and of similar origin. These cannot be classed among the marginal kames.

In "Pope Hollow," close to the line between South Valley township, Cattaraugus County, and Carroll township, Chau-

tauqua County, N. Y., and resting upon the water-shed between Pope Run (a tributary of the Allegheny) and Case Run (a tributary of the Conewango), the moraine is finely shown as a ridge of till, which, stretching completely across the valley, and covered by numerous boulders of gneiss, rises upon the highlands on either side. The moraine ridge here, as in other places, is most prominent *behind* or toward the west.

A very small *marginal kame* runs westward and down-hill from the back of the moraine, in Chautauqua County, as though a subglacial stream had drained the moraine backward, into the valley of the Conewango. The moraine itself is apparently unstratified, and no drift was noticed in front (E.) of it. Its only drainage, therefore, must have been *backward*, into the Conewango.

An interesting *double kame*, consisting of two ridges of sand united into one, the double anticlinals being exposed, was observer by the writer in Mercer County.[1] It is probably not a true marginal kame.

An examination of the marginal kames, of which sufficient examples have now been given, leads, as has been seen, to the conclusion that they were made by *subglacial streams draining the edge of the ice-sheet.* The occasional boulders and till on top of, but not in, these kames argue a subglacial origin, the boulders and till having been dropped by the retreating glacier on the kames; while the position and direction of each of the kames described is just such as would be taken by streams flowing beneath the ice-sheet. Among the facts ascertained with regard to marginal kames are their water-worn and stratified character; their rude anticlinal structure, often of finer sand within than without; the presence of occasional boulders and even *till* on top of them; the absence of any fixed relation to the movement of the glacier; the general coincidence of their course with that of the natural drainage; the total absence of shells, driftwood, beach-marks, or other indications of the action of ocean currents, waves or tides; their intimate connection with the terminal moraine in such positions as to indicate a *backward*, as well as a forward subglacial drainage.

These kames are very different from those tongues of stratified drift which often occur in or near the glaciated region at the

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[1] Report Z, p. 191.

junction of two streams (ancient or modern). These deposits do not show an anticlinal structure, and instead of occurring in the centre of a valley, are seen at points where an eddy in the drift-laden waters, or more commonly the shelter of a projecting rock, has allowed them to be formed. They may be termed *eddy-ridges* or *terrace-deltas*, and are clearly of entirely different origin from kames. The writer has seen a number of such ridges in northern Pennsylvania, and there is little difficulty in distinguishing them from kames.

That stratified deposits may exist beneath a glacier, undisturbed by the weight or motion of the ice, has been shown by observation at the base of the Swiss glaciers. Among the most interesting of these observations, because so well correlated with the phenomena of the American ice sheet, are those of Prof. Chamberlin, made at the base of the Rhone glacier. He remarks:[1] "At other points, near the centre of the valley, the ice may be seen resting directly upon well-assorted stratified sand and gravel. Level sheets of fine detrital matter extend without disturbance of continuity or surface beneath the edge of the glacier. The assorting and stratification of this material was apparently accomplished by subglacial streams, which seem afterwards to have found other avenues, when the ice occupied their place either by settling down from above, or advancing from behind. The singular fact is that the stratified sands should not have been disturbed."

The similarity between the contours of kames and of moraines is accounted for on the supposition that both were moulded beneath the ice sheet. While the moraine shows the edge of the glacier, the kames indicate the direction of its drainage. Flat terrace plains, such as that at Berwick, on the Susquehanna, are made by floods issuing from the front of the glacier, but when the drainage was subglacial, whether forward or backward, kames are the result.

Subglacial Drainage.—The most important conclusion arrived at by a study of the *backward-draining* marginal kames is that of a great *subglacial drainage.* The same conclusion is drawn from observations on the terminal moraine itself, which in many places shows evidence of having been drained *northward*, not southward. Many such instances might be described.

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[1] Wis. Geol. Survey Report for 1878, p. 17.

On the high mountain plateau of Potter County, Pa., for example, at an elevation of 2500 feet, although the Allegheny River flowed at the very foot of the glacier, there is no drift in the valley of the river, and no indication of any drainage to the south; while north of the moraine the whole country is covered with clays, terrace plains, kames and every indication of the presence of both ice and water.

Again, in Columbia County, Pa., although Fishing Creek flows in front of the edge of the ice sheet which once rested on its eastern bank, there are no gravel deposits in the creek; while immediately back of the moraine we find them in great quantities, leading around to another outlet.

So on the Pocono plateau, in Carbon Co., the drainage was reversed; while in Northampton County, and Monroe County it was clearly in both directions, outward and inward.

The writer has adduced evidence that the Allegheny River, near Olean, N. Y., flowed into the glacier and out of it again in the same channel that it now occupies; flowing in a *subglacial* channel through or under a tongue of ice ten miles broad by two miles long.[1]

Everywhere there are indications of a great subglacial drainage. The observations of other geologists, especially of Prof. Newberry, in Ohio, lead to the same conclusion. Studies among modern glaciers confirm these interpretations of glacial phenomena.

Prof. Nordenskiöld described the "large and swift rivers," plunging from the surface into profound crevasses of the Greenland ice-sheet, and Dr. Rink speaks of the copious subglacial streams which flow out from under the Greenland ice.

From beneath the Muir glacier of Alaska,[2] there issues a subglacial stream 100 feet wide, and 4 feet in average depth, the flow being the same winter and summer. Prof. Dana[3] has rightly assumed that the ice sheet of North America would have had "subglacial streams as much more extensive than those of Greenland, as the precipitation was more copious and the drainage areas larger."

Much of the boulder clay and till throughout the lower por-

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[1] Report Z, p. 154.

[2] Meehan, Proc. Acad. Nat. Sc. Phila., 1883, p. 249.

[3] Am. Jour. Sc., xxii, p. 366, 1882.

tions of both the United States and Canada, shows evident aqueous action, not only subsequently to, but during its deposition.

The great lake basins, and the St. Lawrence Valley, receiving subglacial streams from south as well as from north, may have been flooded with water while the ice still covered them.

Important deductions regarding the physical condition of the lowlands while covered by the glacier, and of the origin of certain aqueous varieties of till might be drawn from a further consideration of this subglacial drainage. The method of movement of a great glacier, a problem not yet fully understood, is also largely dependent upon the presence or absence of water beneath the ice.

The northward-draining marginal kames are undoubtedly but an insignificant portion of the widespread deposits made by the subglacial drainage which they indicate.

Since this paper was read at Montreal, Mr. J. H. Kinahan, of Dublin, who was present when the paper was read, has, in an article entitled "On the use of the term Esker or Käm Drift" (Amer. Journ. Science, xxix, 1885, p. 135), criticized the pronunciation and use of the word kame by American geologists; while at the same time reaffirming his belief that "true esker or käm drift" is "due to currents and eddies generated by the meeting or colliding of two or more currents in a mass of water, such as that of a sea or large lake." He argues that because of an ancient Celtic word "cam" or "käm" meaning *crooked* or *winding*, we should pronounce the word kame short, as if spelled căm.

It is not probable that American geologists will adopt this short pronunciation. The word has long been pronounced kame both in England and Scotland, and in the latter country is often spelled *kaim*. Indeed Mr. Kinahan himself formerly used this spelling, and therefore also, the long pronunciation. (See his article "On the Drift in Ireland," Journ. Roy. Geol. Soc. Ireland, vol. i, p. 200, where he speaks of "eskers or *kaims*.")

The now antiquated idea that eskers and kames are due to oceanic or lacustrine currents has naturally enough been held in Ireland, where the land often lies but little above ocean level, but such a theory is untenable in America. Mr. Kinahan himself says, that the marginal kames of America must be quite different from the Irish eskers, and ventures the explanation that "there were at times 'flashes' or areas of shallow water accumulated margining the faces, portions of which were still water, while in other portions there were currents; or it might have been a mass of snow margining a narrow flash of flowing water." This explanation, like one held by Sir William Dawson (Proc. Amer. Assoc. Adv. Sci., xxxii, 1884, p. 25), that the terminal moraine simply marks the "limit of the deep water of a glacial sea," would probably be greatly modified had those geolo-

gists the opportunity of studying in the field the margin of the glaciated area of Pennsylvania.

How could any area of water, still or flowing, accumulate along the margin of an ice sheet which rests against an upward slope, as it so often does in this State? And if such areas of water did exist south of the moraine, why have not some relics of such a body of water been left in the shape of sand, gravel or clay? There is no fact in relation to glaciation more satisfactorily determined in the writer's "Report on the Terminal Moraine" than the absence of any body of water, deep or shallow, in front of the moraine. This unexpected fact is clearly shown by the entire absence of drift south of the moraine except in river valleys (the narrow glacial "fringe," elsewhere described, is excepted). While kames and many other deposits made by melting ice abound immediately back of the moraine, all these stop abruptly at the moraine, and the line of demarkation is at times so sharp that "it is almost possible to stand with one foot upon the glaciated and the other upon the non-glaciated ground" (Second Geol. Surv. of Pa., Z, p. 103).

The study of glacial phenomena is in a much more advanced stage in America than it is in Europe. To the smaller areas studied, and to the artificial changes which have modified the surface deposits of the Old World, are in great part due the limited views, the confusion of terms, and the contradictory theories which characterize much of the very voluminous literature of the glaciation of Europe. No better field for the prosecution of glacial studies can be found than in America, where single deposits extend for thousands of miles under varying conditions of mountain and valley, of flood plains and of prairies, and where in many places they stand to-day almost in the form in which they were originally made, untouched by the hand of man, and gently dealt with by that of time.

DESCRIPTIONS OF NEW SPECIES OF LEPIDOPTERA.

BY HERMAN STRECKER.

Papilio Nezahualcoyotl.

♂ expands 3 to 3½ inches. Head and body of same color, and marked as in the ordinary *Philenor;* all the wings broader, and not nearly as elongate as in that species, and the secondaries without tails.

Upper surface. Primaries blackish brown, with a dark blue shimmer towards the inner angle; a submarginal transverse row of five white spots, the first which is between the discoidal nervules is much the smallest, the next three are of nearly uniform size, and the last one, between the last median nervule and the submedian nervure, is geminate. Fringe near the apex black, from thence to the lower discoidal nervule black and white alternately, and from the latter to inner angle white, with black only at the termination of the veins.

Secondaries dark shining blue, with a submarginal row of six large white more or less lunate spots, the one at anal angle narrow, and much the smallest. Fringe of marginal indentations white; at termination of veins bluish black.

Under surface. Primaries paler than above, markings the same.

Secondaries after the manner of *Philenor*, but the brown of basal half extending over greater area; the continuous submarginal band of large spots of a deeper orange, more inclined to a red or brick-color.

From New Mexico, close to the Mexican border.

This insect bears about the same relation to the true *Philenor* that *Hospiton* does to *Machaon*, or *Anticostiensis* to *Asterius*, though in neither of the latter is there that almost total obsolescence of the wing-tails that so remarkably distinguishes the present form. It would be curious to know by what process nature has effected this abortion of the caudal appendages, and why it should occur in an exceedingly limited extent of territory.

All the examples of *Philenor* which I have seen from California have short tails to the wings, not much over half the length of eastern examples, and often much less; in the Cali-

fornian examples the wings are also broader than in the eastern ones, but there is not that wide aberrancy that marks in a moment the above-described New Mexican form.

The largest examples of *Philenor* that I have seen were from Ohio, Pennsylvania and New York, whilst the smallest were from Georgia, and especially Florida, where, to the contrary, another of our species, the well-known *Turnus*, is found of large and frequently enormous size. The Californian examples of *Philenor* are small, or, at most, only of medium size.

Papilio Cleombrotus.

Expands 3¼ inches. Head and body black; on head are two obscure yellowish spots, two more on the collar, and one on each shoulder. Abdomen with yellow lateral stripes.

Primaries narrow.

Upper surface black, with greenish blue sheen on basal third; a large yellow central spot, partly within the median cell, and partly outside the median nervure. Fringes on upper half outer margin black, on inner half black and white.

Secondaries rounded outwardly, outer margin dentated. Deep shining greenish blue, except along the costa, where the blue shades into or is replaced by black; a row of small white submarginal lunules; dentations narrowly fringed with white.

Under surface. Primaries uniform dark chestnut-brown, with the yellow central spot of upper side repeated.

Secondaries same brown as primaries, with the same small white submarginal lunules of upper surface; above each of these latter is a crimson more or less lunate spot, the one near the anal angle very much larger than the others; at the base of wing three crimson spots placed one at shoulder, one within base of discoidal cell, and one between the median vein and inner margin; this latter is the largest, and is sagittate in shape.

From the condition of the abdomen I am unable to decide as to the sex of the single example on which the above description was based.

Hab.—Amaz. Sup.

This insect is closely allied to *Pausanias* Hew., but differs decidedly from it in the following particulars: In the entire absence of the large pale semitransparent apical patch, and in the fringe of inner half of outer margin being white and black

instead of black only as in its analogue. In the much greater length of secondaries, and in their rounded outer margin, which in *Pausanias* is in a straight line from anal angle to apex. In the secondaries being, except along the costa, entirely blue, whilst in the other species that color is confined to the basal half of wing only.

On the underside in all wings being uniform dark brown, the primaries being devoid of the paler color of outer margin and apical part, as well as of the two or three small yellowish submarginal spots near the inner angle, and in the secondaries being without the alternating pale brown rays which emanate from the submarginal crimson lunules in *Pausanias*, as well as in the absence of the crimson line which in the latter continues from the anal lunule along the median nervure to base.

Both these species imitate in a remarkable manner *Heliconius Clytia*, but the mimicry is more complete in *Pausanias*, owing to its greater length of fore-wing and narrowness of hind-wing.

Of the last-named species I have seen many examples, of the present described only the single type now before me.

Theorema Titania.

Expands 2 inches; form of *T. Eumenia*.

Upper surface. Primaries black, disc and base covered with dark shining greenish scales; apex tipped with a paler silvery green, which is cut with white by the veins at and near their termination; a black marginal line succeeded by pure white fringe.

Secondaries black with a slight powdering of shining green atoms; a fairly broad glittering green marginal band extending from apex where it is narrowest to beyond the last median nervule where it attains its greatest width, this band is cut by the veins, which are black, and is separated from the white fringe by a black line; on the inner margin above anal angle is a small white spot. Tail black, fringed with white.

Under surface. All wings black. Primaries narrowly margined with greenish silver, broadest at apex; fringe white. Secondaries with three parallel rows of bluish white or silvery spots; those nearest the margin are crescent-shape, connected with a marginal line of same color; in the next row they are small, and with the exception of one, which is lunate, are round

or oval; those composing the innermost row are smallest, and slightly and somewhat variously lunate. Fringe white.

From one example taken by the late Prof. Gabb in Costa Rica, now in Mus. Strecker.

On the upper side, omitting the tails, this insect bears a close resemblance to the females of *Eumæus Toxea* and *Minyas*.

There is, as far as I am aware of, but one other species of this genus known, *T. Eunomia* Hew.,[1] from New Granada, from which the one here described is entirely distinct.

Agrias Amydon, Hew. ♀

Expands 3¼ inches. Head black with four minute white spots above; palpi yellowish white. Body above deep ochraceous orange, below black with pale spots and marks. Wings, primaries broader than in the male; exterior margin straight until near inner and outer angles, where it is rounded.

Upper surface. Primaries, basal half, or rather more, bright ochraceous, deepening in tint towards the base; the outer part of wing black; this latter color starts at the inner angle and extends across in an arched line to within the middle of costa, forming a large triangular patch, which covers the outer part of the wing; a dash or an abbreviated band of black extends from inner angle along inner margin to over half its length; a band of three whitish yellow spots cross the black color towards the apex.

Secondaries, black with a small patch of deep ochraceous near the base, and a whitish edging at the apex.

Under side of all wings colored and marked as in the male, with the exception of the ground-color of primaries, which is ochre yellow instead of red.

Described from a single example which came to me in a lot of several thousand butterflies, taken at or near Pebas, on the Peruvian Amazon.

On the upper side this insect is the exact counterpart on a gigantic scale, of *Catagramma Sinamara* Hew., and (if my example, received from Mr. Hewitson be that species) of *C. Amazona* Bates, which is doubtless the ♀ of *C. cynosura* Hew., and further between which and the figure of *C. Sinamara* I can see no difference.

[1] Hew. Ill. Diur. Lep., p. 69, t. 27, figs. 1, 2 (1865).

As far as they are known the females of the red species of *Agrias* mimic in an extraordinary manner the females of certain *Catagrammas*, and the blue ones the same sex in some of the species of *Callithea*.

Plusia corusca.

Size and shape of *Mortuorum* Guen. Head and body pale brown, inclining to ochrey beneath.

Upper surface. Primaries, ground color brownish pink; sinuate white or silvery basal and transverse anterior lines edged irregularly with deep bronzy brown; a transverse posterior line, this latter is broken, irregular, of exceeding fineness, and edged at intervals with deep brown; the space between this line or band and the transverse anterior line, and between the median nervure and inner margin is a deep golden or coppery bronze, according to the light in which it is seen, the same shade occupies most of the space between the submarginal, which is pink and sinuate, and the transverse posterior line, and also covers, except at inner angle, the space between the former and the exterior margin; a large and very distinct gamma mark as in *P. gamma* L.

Secondaries brownish, pale and ochraceous at basal half, and smoky on outer half.

Hab.—Colorado. One example, Mus. Strecker.

Though in detail the markings are somewhat different, still this insect forcibly reminds one of *P. mortuorum*, were the silver ground of the latter to be replaced by coppery bronze the resemblance would be very strong.

Plusia alterna.

Expands $1\frac{3}{4}$ inches. Allied to *Ampla* Wlk., but entirely distinct, all wings narrower than in that species, and primaries not as much produced at inner angle. Head and thorax light ashen or purplish gray; patagiæ with broad, dark brown margin, which color forms a continuous band across the back. Abdomen light brown.

Primaries of an even, shining pale, somewhat purplish gray, and without the shading and clouding of outer half as in *Ampla*; a large dark space interior to the median nervure, and between the transverse anterior and posterior lines, this space is a dark rich brown, shading into black at upper part where it is outlined by a

strong, well-defined silver mark, straight nearest to base, hooked outwardly; this mark is quite different from the nearly straight insignificant mark of *Ampla;* above the outer edge of the dark central patch, the transverse postèrior line is double and inconspicuously continued towards the costa; the transverse anterior line does not extend beyond the central patch, only at the place where it should terminate on the costa, is a dark spot. A small dark inconspicuous apical spot.

Secondaries orchrey brown, shading into smoky towards outer margin.

Hab.—Colorado. One example, Mus. Strecker.

June 9.

Dr. Geo. A. Koenig in the chair.

Seventeen persons present.

June 16.

Dr. W. S. W. Ruschenberger in the chair.

Fifteen persons present.

The death of Dr. J. Henle, a correspondent, on May 15, 1885, was announced.

June 23.

Mr. John H. Redfield in the chair.

Fourteen persons present.

A paper entitled "Descriptions of new species of Partula, and a synonymical catalogue of the genus," by Wm. D. Hartman, M. D., was presented for publication.

June 30.

Rev. Henry C. McCook, D. D., Vice-President, in the chair.

Twenty-eight persons present.

A paper entitled "Cervalces Americanus, a fossil Moose, or Elk, from the Quaternary of New Jersey," by W. B. Scott, was presented for publication.

July 7.

Mr. Thomas Meehan, Vice-President, in the chair.

Fifteen persons present.

The death of Dr. Franklin B. Hough, a correspondent, on June 11, 1885, was announced.

The following were ordered to be printed:—

CERVALCES AMERICANUS, A FOSSIL MOOSE, OR ELK, FROM THE QUATERNARY OF NEW JERSEY.

BY W. B. SCOTT.

Several species of Elk or Moose have been found in the Quaternary deposits of the United States, and have been described by various observers. For the most part, however, the remains described have been so imperfect as to be of little value from a morphological point of view. The earliest account we have of such fossils is to be found in the Proceedings of the American Philosophical Society for 1818, p. 375. This is "an account of two heads found in the morass called the Big-Bone Lick, and presented to the Society by Mr. Jefferson," and was written by Dr. Caspar Wistar. One of these heads is assigned by Dr. Wistar to *Cervus*, and is thus described: "If it belonged to the genus *Cervus*, it was one of the largest species of that genus.

"The comparison of figures 4 and 5 with figures 6 and 7 (skull of wapiti), shows that the lately discovered skull resembles that of the Round-Horned Elk at the occiput, although it differs from it greatly in the position and projection of the horns. There is also in the Round-Horned Elk a considerable prominence of the frontal bone between the bases of the horns, which does not appear to have been the case in the newly-discovered head. [In part, at least, this is due to abrasion of the specimen.—S.] The bones of this last-mentioned head have a concavity or depression on the under surface near the root, which is not the case in the Round-Horned Elk.

"The cranium of the Moose, or *Cervus alces*, is very different. The occipital portion is concave exteriorly, and the superior margin has an angular indentation in it. There is a remarkable prominence between the horns, which extends considerably towards the nose. The horns of it project laterally like those of the newly-discovered head, and they have a concavity on the under surface near the root." . . . "I believe that each of the last-mentioned heads (*i. e.*, wapiti and moose), is at least of the ordinary size, as their horns are large, and it appears, from a comparison of the respective measurements, that the head lately discovered is larger than either of them."

Wistar did not name the species here described; this was done in 1825 by Harlan, in his Fauna Americana, who called it *Cervus americanus.* The only addition of importance to our knowledge of this species we owe to Dr. Leidy, who, in his "Ancient Mammalian Fauna of Dakota and Nebraska," p. 379, describes a pair of metacarpals accompanying the head described by Wistar, which Leidy says indicate an animal of greater stature, but more graceful proportions, than the great Irish Deer.

When Harlan named the species, the genera *Cervus* and *Alces* had not been separated; their later separation gave rise to a great confusion of nomenclature. In 1835 Sir William Jardine (Naturalists' Library, vol. xxi, p. 125), elevated *Alces* into a distinct genus, and called the American species *A. americanus.* Jardine supposed that Harlan's species was a true *Cervus*, and refers to it as the "fossil cranium and horns of a stag, . . . to which Dr. Harlan has applied the name of *C. americanus,*" (p. 162). In 1836 Ogilby named the European elk *Alces machlis* (P. Z. S., 1836, p. 135), the name now generally employed for both varieties, while Harlan's name for the species described by Wistar has never been disturbed or questioned. But judging from Wistar's specimen, it becomes at once evident that this species is altogether different from *Cervus*, and belongs either to *Alces* or some closely allied genus. If it is to be classed in *Alces*, its specific name must be *A. americanus*, which name has been used by Jardine for the American moose. It will thus be seen that a serious confusion of names has arisen.

No other American fossil moose has received a special name, though many specimens have been found, some of the finest of which were in the Museum of the Chicago Academy of Sciences, and were destroyed in the great fire of 1871.[1]

Through the kindness of the Rev. A. A. Haines, the Museum at Princeton has received an almost complete skeleton of a very large extinct species of elk or moose, which was discovered in a shell-marl deposit under a bog at Mt. Hermon, New Jersey, six miles from Delaware Station on the Delaware, Lackawanna and Western Railroad. This superb specimen is practically complete, the only missing bones being five caudal vertebræ; two ribs; the right scapula and humerus; the right unciform and pisiform, and

[1] See Judge Caton's Antelope and Deer of America, p. 104.

the trapezium of each side; one anterior ungual phalanx; the left calcaneum, and a number of bones of the rudimentary lateral digits. With the exception of the caudal vertebræ every missing bone of importance is represented by its fellow of the opposite side, so that it was well nigh impossible to go astray in making the necessary restorations.

The skeleton was of an adult, but not old, individual, as is shown by the condition of the epiphysis and teeth. The missing parts have been restored, and the entire specimen most skilfully mounted by Curator F. C. Hill. (See Pl. II).

A careful comparison of the Princeton specimen with that described by Wistar, which, together with the metacarpals described by Leidy, is preserved in the Academy of Natural Sciences of Philadelphia, convinces me that in all probability the two specimens belong to the same species. There are some unimportant differences and the old specimen is too imperfect to put this identification beyond question. But what remains of the Philadelphia skull agrees almost perfectly with the Princeton one, and at present there can be no reason for assigning them to different species.

On examination, however, it becomes evident that the species in question cannot be included in any known genus, as these are at present defined. While its affinities are undoubtedly closest to *Alces*, yet if we include it in that genus, the generic definition must be altogether remodeled and some of its most prominent characteristics would have to be suppressed. The differences from all known species which this fossil form shows, are of sufficient importance to entitle it to rank as a separate genus. With considerable reluctance, therefore, and in view of the confused nomenclature of the species, I feel compelled to form a new name for the genus. I would propose the name *Cervalces*, as indicating the types which it seems to connect. The genus may be defined as follows: *Cervalces.* Antlers dichotomous and palmated, though much less so than in *Alces;* beams horizontally directed, as in that genus, but with much longer pedicels; bez-antler and posterior tine present as in *Dama*, but these are connected by a broad and flaring process of bone, which descends below the level of the eyes. This does not occur in any other member of the *Cervidæ.* Nasals much longer than in *Alces*, a little shorter than

in *Cervus;* anterior nares very much smaller than in the former, but larger than in the latter; premaxillæ shaped as in *Cervus* and reaching the nasals. Head broader than in *Alces*, prominence on frontal ridge and supra-occipital indentation absent. Upper and lower molars with supplementary columns; no upper canines. Ante-orbital vacuity bounded above by a separate bone (prefrontal?). Neck and trunk short, legs exceedingly long. Distal ends of lateral metacarpals present; internal cuneiform fused with the metatarsal.

As Harlan's name must undoubtedly be retained this species will be known as *Cervalces americanus.*

In the skeleton of this curious and striking fossil, the most obvious peculiarity is the great length of the legs, which gives the animal a remarkably stilted appearance, while the thorax is shallow, and the neck short. The shoulders are higher than the hips, as in the moose, and unlike the stag. The combined length of the head and neck shows that in the ordinary position of the legs, the muzzle would not reach the ground by 14 or 15 inches. Measured in the same manner the moose's muzzle reaches within about 10 inches from the ground, and that of *Megaceros* 8 or 9. These facts are of importance with reference to the question of the animal's habits and the presence of a prehensile upper lip.

Turning now to the characteristics of the skeleton in detail, we begin with:

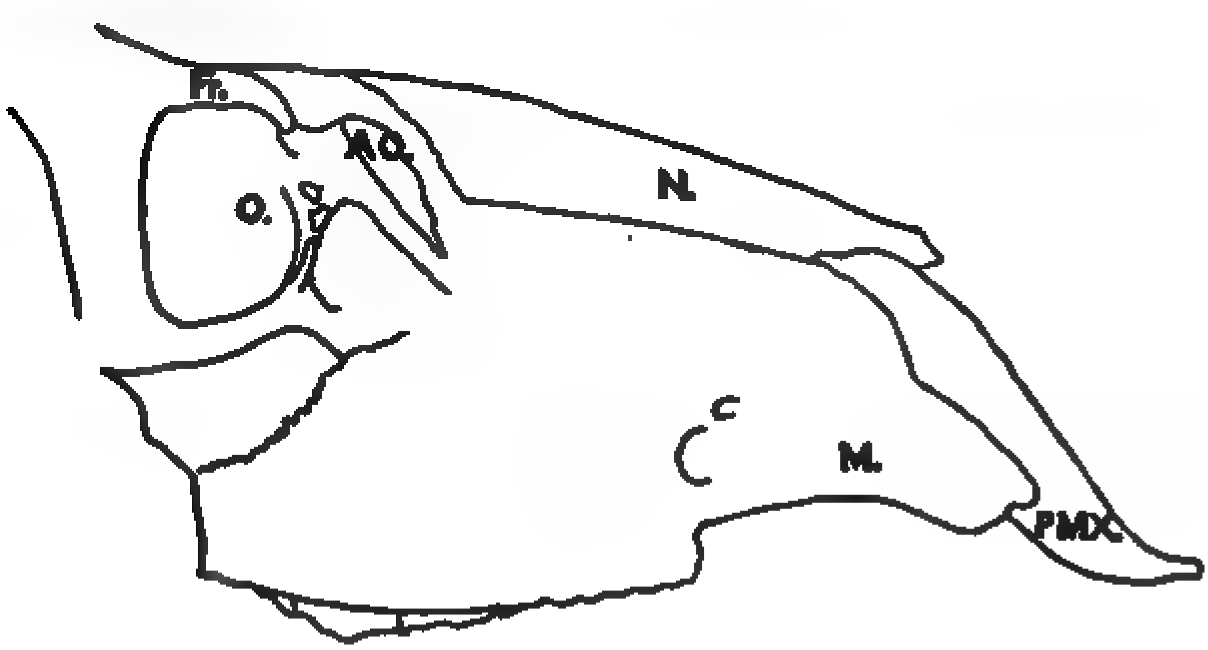


FIG. 1. Side view of face of *Cervus Canadensis.*

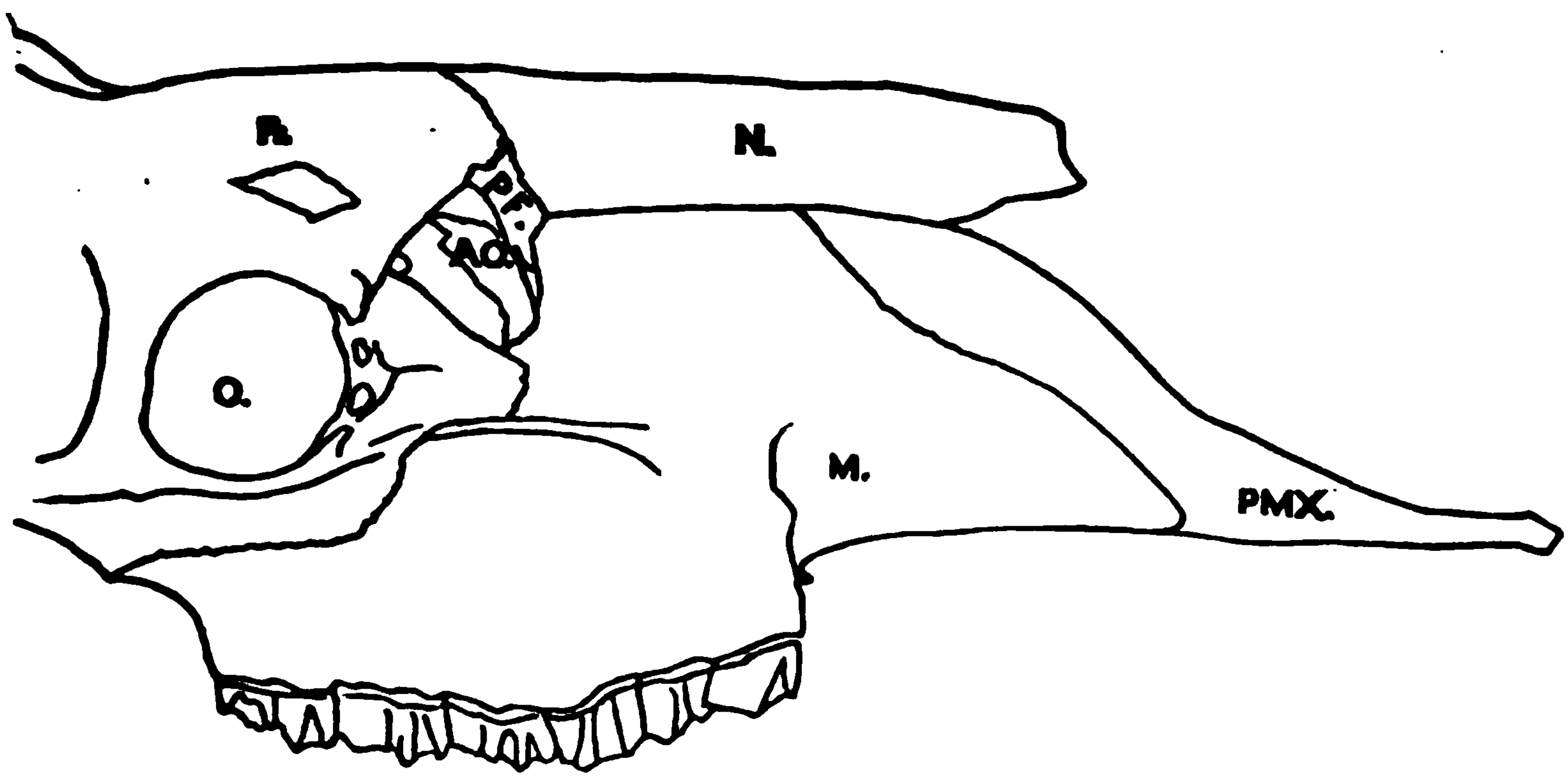


Fig. 2. Side view of face of *Cervalces Americanus*.

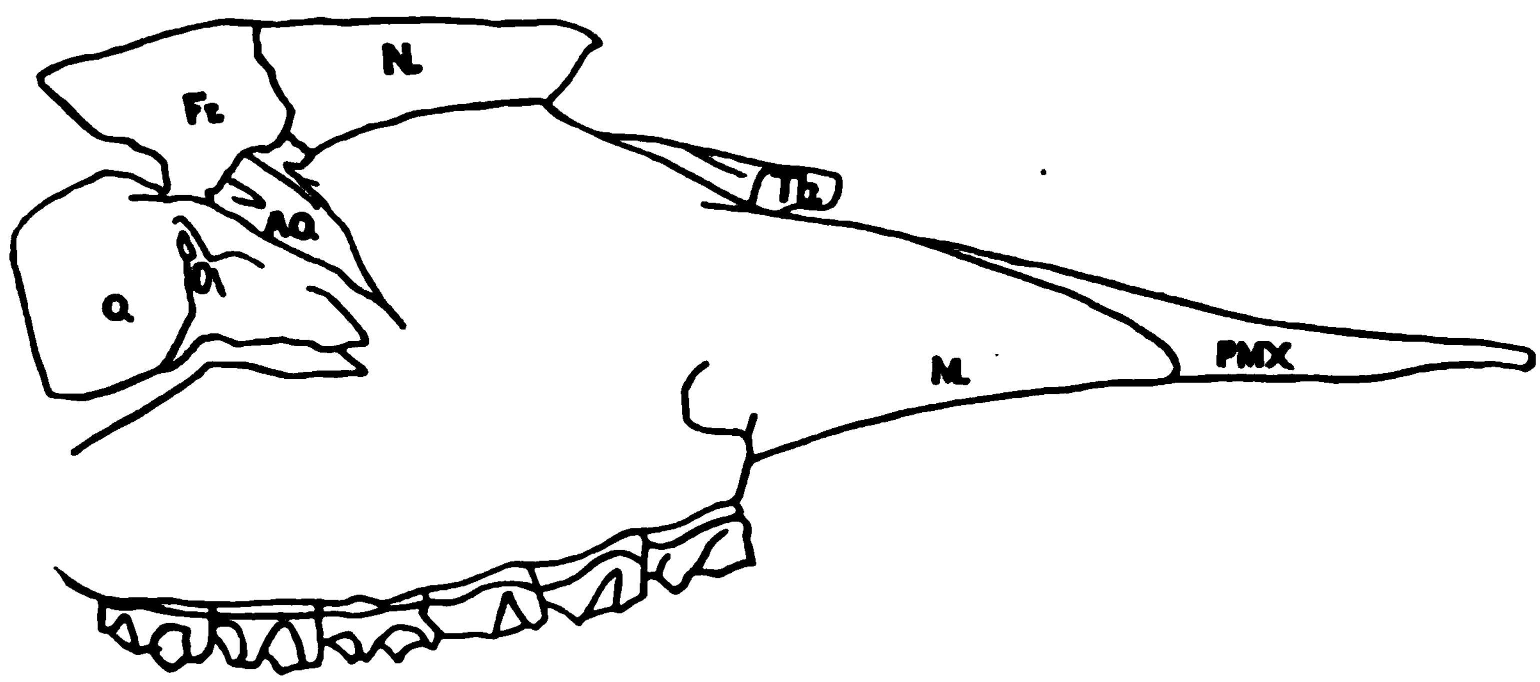


Fig. 3. Side view of face of *Alces machlis*.

The Skull.

The skull resembles most that of the living moose, though strikingly different from it in many respects, in which it approximates to *Cervus*. In spite of the greater size of the animal, the skull is both absolutely and relatively shorter than in the moose; this reduction, however, is chiefly confined to the region in front of the molar teeth. The cranium is considerably broader than in *Alces*, especially between the bases of the antlers. The appearance of that part of the face which is in advance of the molar teeth is strikingly different from the same region in the moose, and approximates rather that of *Cervus* (see figs. 1, 2 and 3). This difference is further increased by the fact that the nasals

of the fossil are more than twice as long as in the moose; this increase of length of the nasals, together with the shortening of the face renders the appearance of the anterior nares very different from those of the moose. The edge of the nares in the latter measures nearly 11 inches, in the fossil hardly 8; in a large skull of *Cervus canadensis* the measurement is 4½ inches.

The *Premaxillæ* are like those of *Cervus* and not at all like those of *Alces;* they lie external to the anterior ends of the maxillæ and reach up to the nasals with which they articulate by a surface nearly an inch in length, while in the moose the ascending ramus of the premaxilla is inserted into a groove in the front edge of the maxilla and does not reach the nasals by several inches. This is not due merely to a shortening of the nasals, for though the ascending ramus is very long, its direction is so oblique that it does not rise to the level of the nasal, and no prolongation of the latter would effect a junction. The shape of the premaxilla is also very different in the two species, the horizontal portion being shorter, the ascending portion longer, and the posterior angle between the two sharper in the fossil than in the recent form. In all these respects the former shows an approximation to the shape of the bone in *Cervus*. Seen from the side the edge of the nasal opening is very different from that of the moose. In the latter this edge is very long and directed obliquely downwards and forwards (see fig. 1), while in the former the descent is much more abrupt. The whole tube inclosing the nasal cavity is much longer than in the moose, in which animal the turbinal bones project beyond the edge of the premaxillæ (fig. 3), and so can be seen from the side, while in the fossil they do not quite reach the edge of the nares (fig. 2).

The *Maxillæ* are more like the corresponding bones of *Cervus* than those of the moose. The difference, however, is almost altogether in the anterior part. The front edge is much less oblique and takes no part in the formation of the anterior nares. The edentulous part of the bone in advance of the molars is much shorter than in the moose, but the upper facial portion is of about the same length. As in *Alces*, the palatine plates in front of the molar teeth are contracted much more than in *Cervus*. There is a further difference from either of the genera in the fact that the alveolus behind the last molar is very narrow and short,

ending in a mere hook. The condition is not unlike that seen in *Megaceros*.

The *Nasals* are intermediate in size and shape between those of *Cervus* and *Alces*. In *C. canadensis* these bones are about $\frac{2}{5}$ the entire length of the skull, in the moose a little less than $\frac{1}{6}$, in *Cervalces* $\frac{1}{3}$. In length, in their narrower and emarginate free ends, the nasals are like those of the true deer, but resemble those of the moose in not being so flat, but having the upper and lateral parts meeting at nearly a right-angle. The nasals in the fossil are in contact throughout their entire length, not having their posterior ends separated by the wedge-shaped process of the frontals, as is the case in the moose. These posterior ends are sharper and less abruptly truncated than in the latter animal.

The length of the nasals and shape of the anterior nares in *Cervalces* show that if the animal possessed a proboscis-like snout at all, it could not have been anything like as prominent and well developed as in the moose; such a proboscis being always accompanied by a great shortening of the nasals, as in the elephant, tapir, moose, *Sivatherium*, etc.

The *Frontals* present us with another difference from the moose and resemblance to the deer. As in both genera, there is an abrupt depression of the forehead in front of the antlers, but this is less than in *Alces*. In the latter there is a sharp knob on the ridge connecting the pedicels of the antlers, but in the fossil this knob is but faintly indicated. The forehead is broader and the orbits more projecting than in the moose, in both respects showing approximations to the cervine type.

The *Lachrymal* is of the ordinary size and shape, but the pit is unusually shallow. The ante-orbital vacuity is more quadrate in shape than is the case in *Alces*. The upper edge of this vacuity is bounded by a small distinct bone which I have not been able to find in any other of the *Cervidæ*, though what looks like a rudiment of it is attached to the nasal in the moose. The bone in question articulates with the nasal, frontal and maxillary; thus in position corresponding to the prefrontal, though morphologically it may be a separated portion of the nasal. It is hardly probable that this is a mere sport, as the bone is present on both sides, and is certainly a great peculiarity. (Fig. 2, *P. F.*)

The *Jugal* has more the shape of that in *Cervus* than that of

the moose, in the simpler maxillary suture and shorter anterior process. The orbit is somewhat smaller than in the moose, and more nearly circular, the vertical diameter being greater in the latter, while the antero-posterior diameter is about the same in both. While the frontal rim of the orbit is more projecting than in *Alces* and the whole orbit is deeper, the jugal rim is less distinctly marked off from the body of the bone.

The *Squamosal*, with its zygomatic process, is almost exactly like that of the moose, the zygoma being directed downwards and forwards, instead of being almost horizontal as in the other *Cervidæ*. This peculiar shape of the zygoma is due to the great depression of the forehead, which, though somewhat less than in the moose, is greater than in the deer. If the plane of the upper molar alveolus be produced backwards, it will be found that the distance from the summit of the sagittal crest to this plane is much greater than in *Megaceros* (*Cervalces* 9 in., *Megaceros* not quite 6).

The *Occiput*. As Wistar pointed out, the occiput of the fossil is rather deer-like, in lacking the indentation of the supra-occipital, and in the greater flatness of the entire occiput. As in the moose, however, the condyles are nearly in contact below, while in *Cervus* they are quite widely separated. The basi-occipital has two large rugosities just in advance of the condyles, as in *Alces* and *Megaceros*. The paroccipital processes are stout and of the same shape as in the moose, though somewhat shorter. The proportions of the exposed part of the periotic are about as in that animal. The same is true of the tympanic which does not form an inflated auditory bulla.

The structures at the base of the skull—sphenoids, pterygoids, palatines, vomer and turbinals—need no special description, being very much as in the moose.

The *Inferior Maxillary* resembles the corresponding bone in the moose more than that of the other *Cervidæ*, but with some differences. The jaw, as a whole, is somewhat shorter and broader, the diastema and symphysis slightly shorter, and the coronoid process shorter and heavier.

The *Dentition* is like that of the moose, though with some cervine features. The crowns of the upper molars are shorter than in *Cervus*, but as in some species of that genus they have

well-marked internal supplementary columns; all the lower molars have distinct external columns. In some specimens of the moose there is a small column on the first molar, a slight indication of one on the second, and none on the third; in others the second and third have small rudimentary columns. This may, perhaps, indicate that in this species the columns are in process of disappearance, having vanished in the upper jaw from all but the first molar. According to Owen, these columns are present in the upper molars of *Alces* (Brit. Foss. Mam., p. 450). This may be true of the Swedish elk, but not of the American specimens I have been able to examine. These supplementary columns do not appear to be constant generic characters, perhaps not even specific, though this latter is doubtful.

The stylo-hyals are present in the specimen, but are not especially peculiar.

The *Antlers*. The most striking peculiarities of *Cervalces* are to be found in the antlers, which are different from those of any of the *Cervidæ*, recent or fossil, with which I have been able to compare it, or of which I have seen any figure or description.

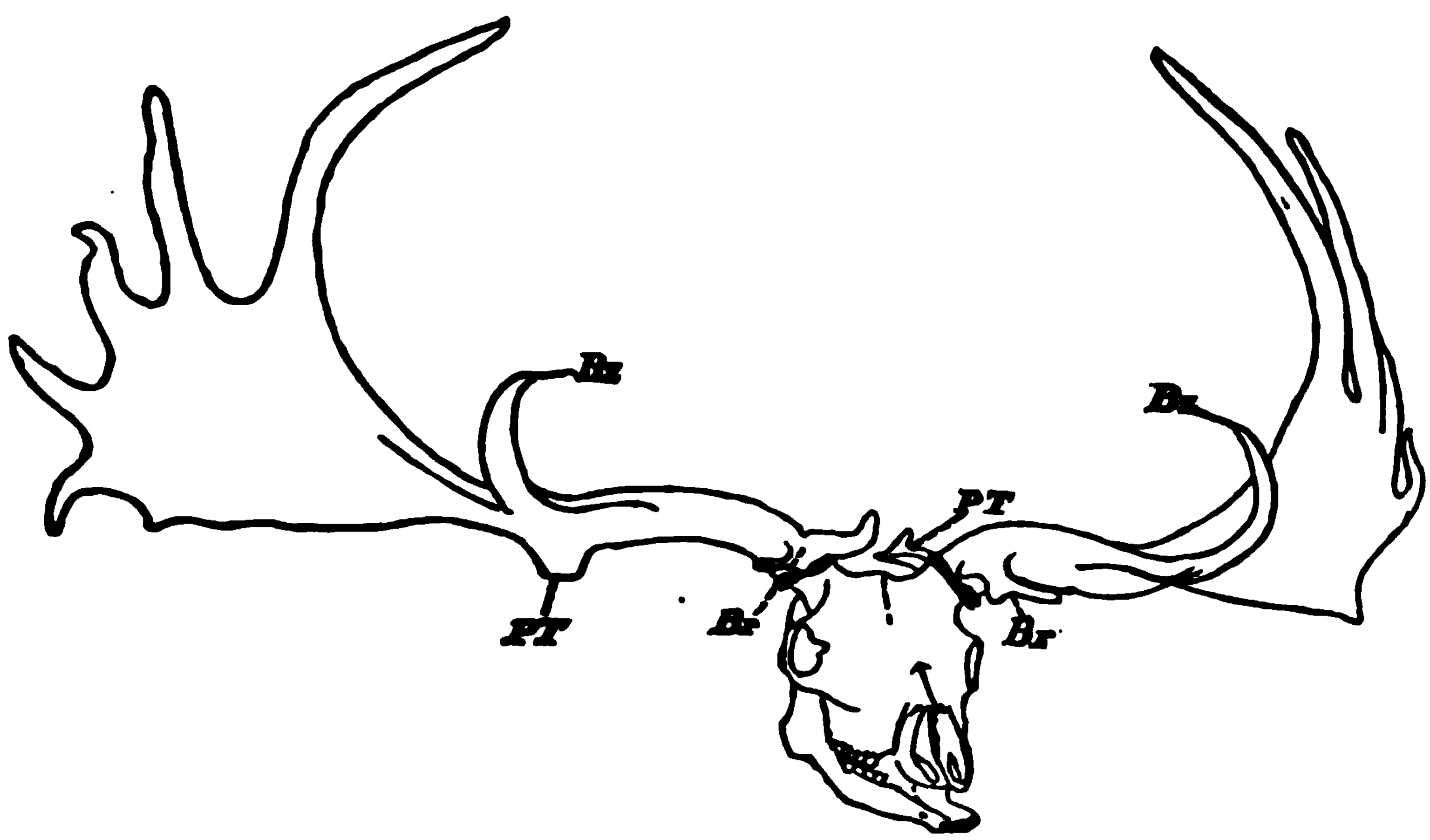


FIG. 4. Skull and antlers of *Megaceros hibernicus*.

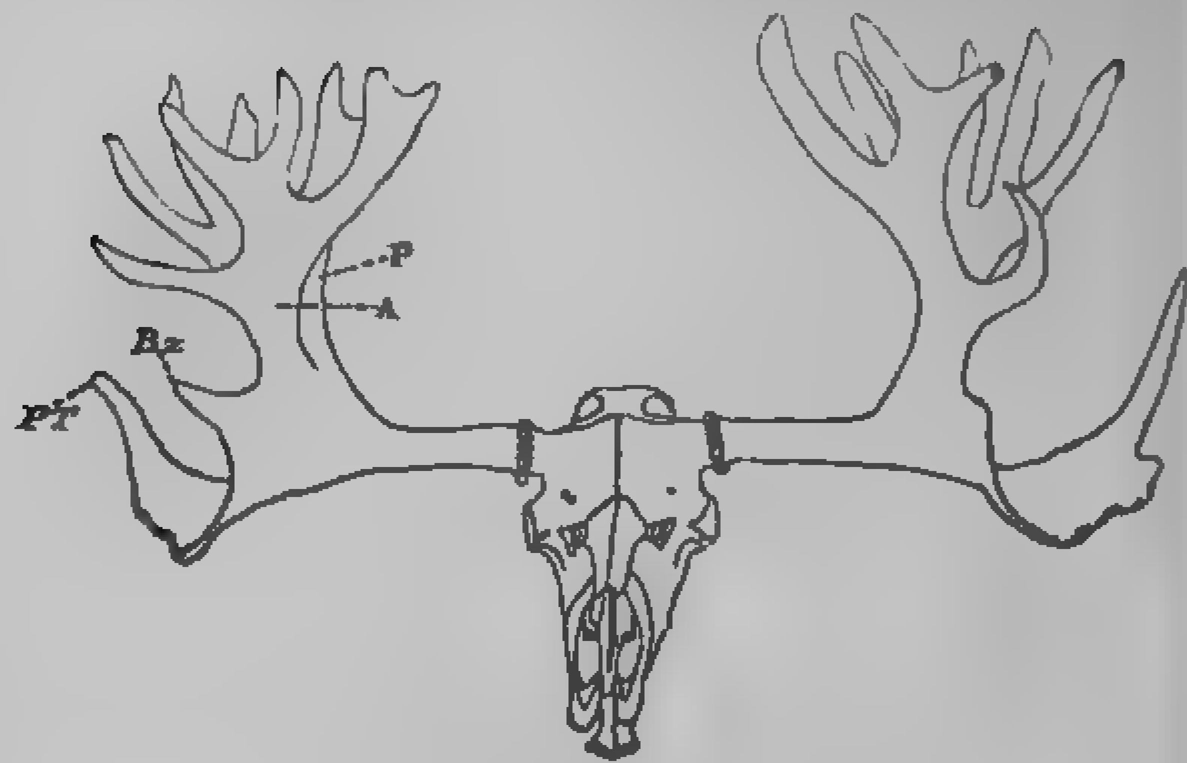


FIG. 5. Skull and antlers of *Cervalces Americanus*.

FIG. 6. Skull and antlers of *Alces machlis*.

The pedicels have an altogether horizontal direction, are somewhat longer than in the moose, and show a deeper posterior constriction, to allow the unobstructed movement of the coronoid process. The burrs are quite widely separated, almost an inch more than in the specimen described by Dr. Wistar. The beam is directed horizontally outwards, as in *Alces*, even drooping a little, as noticed by Leidy, and is unusually long before reaching the point of branching. Leaving out of account for the present the peculiar portion of the antler, it obviously belongs to the palmated dichotomous type of *Alces*. The ordinarily accepted view with regard to the antlers of that animal is that brow-antlers are not present. Sir Victor Brooke, however, considers the anterior division of the antler the homologue of the brow-branch (P. Z. S., 1878, p. 915). Assuming the correctness of the ordinary view, the fossil form agrees with the recent in being devoid of the brow-branch. The main antler is divided into two palmated portions, of which the anterior is the smaller, though it is both proportionally and absolutely much larger than in the moose (figs. 5 and 6, *A*). This portion is twisted on itself so that its flat side is presented forwards in a plane almost at right-angles to that of the posterior division. The palmation of this anterior portion is somewhat more pronounced, and the tines more flattened than in the moose. In the figures all the tines appear somewhat blunt, though this is due to the fact that the animal died while the antlers were yet in "the velvet." In the moose the division into the two palms takes place in a plane only a little above the level of the frontal ridge (2¼ in.), in the fossil the beam turns sharply upwards for several inches (6½) before the point of separation is reached. The appearance of the anterior branch is very different from what is seen in the moose. In the specimen before us there arises from the point of division a narrow flat plate somewhat twisted on itself, which gives off a sharp and stout lateral tine, two or three inches above the point of division; above this tine the plate broadens for a little distance and then bifurcates. On the right side both of these divisions are again bifurcated, the outer one much more deeply than the inner; on the left side the inner prong does not divide, though it is broad and flat. This gives five prongs on the right side and four on the left. Except the lateral tine, all the tines are flattened antero-posteriorly, having a plate-like appearance from the front.

In the moose, on the other hand, the anterior division shows a broad basal palm, which sends up a number of long, sharp and rounded tines, all arising at about the same level (fig. 6, *A*), though adjacent ones may be more or less connected by palmation.

The posterior division of the antler also differs markedly from that of the moose in being much smaller and much less palmated. The size of the palm in its greatest diameter being 9 by 8 inches, while in one specimen of the American moose at Princeton these dimensions are 28 by 17 inches. In the latter animal the tines of this division of the antler are, with the exception of the first mere finger-like processes from the top of the palm (fig. 6). In *Cervalces*, as in the European elk, and some specimens of the American moose, the tines are very much longer, though the palm in the European variety is still much greater than in the fossil. Owing to the height at which division into the anterior and posterior branches of the antlers takes place in *Cervalces*, the first tine of the hinder branch is very much shorter than in the moose (*Cervalces* 13½ inches, *Alces* 21 inches).

The proportionate number of tines in the two divisions is also different in the living and extinct species. In one American moose I find the numbers to be: right antler, anterior 3, posterior 8; left, ant. 4, post. 8. Another specimen gives: ant. 2, post. 5; in a third specimen, ant. 4, post. 8. A European specimen gives ant. 4, post. 7; another is ant. 3, post. 6. In the fossil, on the other hand, we have on the right side, ant. 5, post. 5; left side, ant. 4, post. 4; showing a different method of growth in *Cervalces* from that observed in any known species of *Alces*.

The feature, however, which differentiates the antler of *Cervalces* from that of all other known *Cervidæ* remains to be described. Where the upper edge of the beam rises to form the palmated portion of the antlers, the lower edge expands into an immense concave process, which is presented outwards like the mouth of a trumpet, and which ends both anteriorly and posteriorly in a round, pointed tine, the latter being long, the former quite short (fig. 5, *P. T.* and *Bz.*). The posterior tine is directed obliquely outwards and backwards, so that the distance between those of the two antlers exceeds five feet. On the left side there is a rudimentary tine or snag at the base of the long posterior tine, on the right

side the broad plate of bone gradually tapers off into the tine. It is a curious fact that these great ear-like processes descend considerably below the level of the eyes, so that the animal's vision in a lateral direction must have been seriously interfered with. It is difficult to understand how any such structure of the antlers could have arisen or what its purpose was.

On comparing the antlers of the extinct species with those of the moose, it becomes evident that the former consist of the same parts as those of the latter, with something added to them. Just what these additional parts are is by no means easy to say. The anterior tine (of the ear-shaped process) may be the bez-antler, while the posterior one may correspond to the tine which in *Megaceros* (figs. 4 and 4 *a*, *P. T.*), the fallow deer (see Brooke, P. Z. S., 1878, p. 914, fig. 9), and some others, is given off from the hinder surface of the beam nearly opposite the bez-antler (*d* in Brooke's system). If in *Megaceros* the palmated portion of the antler were bent sharply upwards nearly at right-angles with the beam, the posterior tine directed more outwards and connected by a broad and flaring plate of bône with the bez-antler in front, the resulting condition would be very much what we find in *Cervalcės*. If this conjecture as to the homologies of these tines be correct, Sir Victor Brooke's views on the parts of the moose's antler can hardly be accepted (P. Z. S., 1878, p. 915). It is worthy of notice that in *Cervalces* almost all the weight of the antlers is in advance of the occiput. To a much smaller extent this is true of the moose, while in most of the *Cervidæ* the weight is entirely back of the occiput.

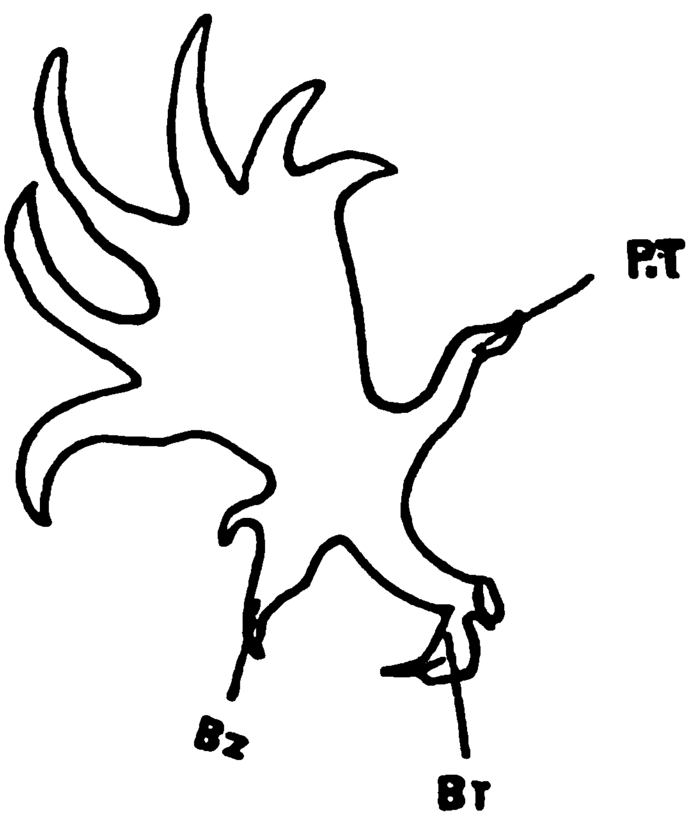


FIG. 4 *a*.
Right antler of *Megaceros hibernicus*, from the inside.

It might be suspected (as for a time I did suspect) that in this fossil we have to do with a case of monstrosity rather than with a true species character—some such phenomenon as the double-

palmed moose antlers from Sweden, and those found fossil in America, as illustrated by Judge Caton,[1] or as in the case of the curiously palmated antlers from Texas, reported by the same observer (*American Naturalist*, vol. xviii, p. 736). While of course this may possibly be the case, it seems very improbable for the following reasons: (1) The symmetry of the antlers, which show no sign of injury or distortion, and which are precisely alike on both sides, except that on one side two tines are bifid, which on the other are single. But such inequality is very common on all large antlers; in fact, is rather the rule than the exception. The double-palmed antlers of which Judge Caton speaks are so only one side. (2) Monstrosities, except in cases of atavism or in mere *repetition* of parts normally present, are much more apt to be in the direction of simplification than of increased complexity. It is therefore very unlikely that these antlers are simply sports from the ordinary *Alces* type, for they contain elements which are never found in the moose, but which seem rather to belong to the true deer.

Gray's view that *Cariacus* lacks the brow-antler can hardly be correct, as the so-called "basal-snag" of that genus is clearly nothing else. Prof. Cope's statement[2] that palmation of the antlers transfers a form from *Cariacus* to *Alces*, is one that I cannot accept. Of the many differences which separate the two genera, the palmation of the antlers is the least important. Any such transfer must ignore the much more significant features of the teeth, skull, and limbs.

SKELETON OF THE TRUNK.

Cervical Vertebræ. The neck is short when compared with the height of the animal, shorter even than in the moose. The atlas is provided with a large and heavy hypapophysis, of which only a small rudiment is to be seen in the moose or in *Megaceros*, but is quite well developed in *Cervus elaphus*. Richardson, however, figures a moose's atlas from Canada, in which the hypapophysis is very distinct (Zoology, Voyage of Herald, pl. xxi and xxii). The remaining cervicals show only differences of detail from those of *Alces;* thus the transverse process of the axis is more slender,

[1] Antelope and Deer of America, p. 194.

[2] American Naturalist, vol. xviii, p. 738.

the pleurapophysial plate on the sixth vertebræ is smaller, that on the fifth larger.

The only other member of the *Cervidæ* with which *Cervalces* can be compared in size, is the great extinct Irish deer *Megaceros*. But in the latter we find a very much longer neck, the vertebræ of which are vastly heavier, and all the processes are larger and stouter, showing the great muscular power necessary to wield the immense antlers. In *Cervalces* the cervical vertebræ appear puny in comparison.

Trunk Vertebræ. In *Megaceros* these vertebræ are provided with very long and heavy spines; those of the anterior thoracic being twelve or thirteen inches in length, on the posterior about eight. In *Cervalces* the spines are shorter and especially lighter. The rise of the back at the withers is even less marked than in the moose. The vertebral centra are also shorter and lighter than in *Megaceros*, giving a much shorter trunk. The lumbar, sacral and caudal vertebræ do not differ in any important way from those of the moose, except that the neural spines of the sacrum are somewhat more closely co-ossified.

The *Ribs* are rather short, only a very little longer than in the moose, and therefore proportionately considerably shorter. The thorax is consequently shallow, and together with the long limbs gives the animal a stilted appearance. The greatest depth of thorax from tip of neural spine to the sternum is in *Megaceros* 34 inches, in *Cervalces* 29, in the moose 28.

The *Sternum*, curiously enough, is somewhat different from that of the moose; the manubrium being smaller and of a somewhat different shape. The first two segments of the mesosternum resemble the corresponding parts in *Cervus*, and differ from those of *Alces* in being long and narrow, instead of short and broad.

The Limbs.

The limbs are remarkable for their great length and slenderness. Though considerably longer than those of the great Irish deer,[1] they are not nearly so stout. The hind legs are especially long, but the withers are higher than the rump, as is the case

[1] It is very unfortunate that the name "Irish Elk" is so commonly applied to this animal, which seems rather to have been a gigantic fallow-deer.

with the moose. The *Scapula* is rather small in proportion to the size of the animal, being a little shorter than in the moose, and much more so than in *Megaceros*. In shape the bone is more cervine than alcine; the anterior border is straighter, and the prescapular fossa smaller than in the moose, while the neck is less contracted and the coracoid larger.

The *Humerus* is not different in any important way from that of the moose, except for a slight increase in length.

The *Ulna* and *Radius* show a still greater increase in length, but are only slightly thicker than in the moose, so in proportion they are more slender. As in *Alces*, the two bones are co-ossified only at the distal end, instead of being firmly united for two-thirds their length as in most deer.

The *Carpus* is like that of the moose in almost every particular, consisting of scaphoid, lunar, cuneiform, pisiform, trapezium, trapezo-magnum, and unciform.

The *Metacarpus* is very long, much of the great height of the animal being due to it. It is about one-half an inch shorter than in the largest of the two Philadelphia specimens, but the proportions are almost identical. The rudimentary lateral metacarpals are like those of the moose in shape, but are longer.

The *Phalanges* of the median digits are unusually long and slender, even when compared with those of the moose. The unguals are very long and pointed. The phalanges of the rudimentary digits are larger and heavier than in the moose.

The *Pelvis* is almost precisely like that of the moose, and needs no particular description.

The *Femur* is slightly longer, but no heavier than in the moose, and offers a striking contrast to the massive thigh-bone of *Megaceros*, which is as heavy as that of an ox. The trochlear groove is shallow, with sharp edges, and the patella is small. The great trochanter is higher than in the *Megaceros*, and rises more vertically from the shaft, but all the other processes for muscular attachment are much less prominent.

The *Tibia* is an exceedingly long bone, but its increase in length has not been accompanied by any corresponding increase in thickness. The astragalar groove is like that of *Alces*, the fibular facet and the fibula are like those of *Cervus*.

The *Tarsus* is somewhat longer than in the moose, of about the same length, but narrower than in *Megaceros*. The calcaneum is nearly an inch longer than in either form, giving a prominent "hock-joint." In the smaller bones of the tarsus we find some curious relations. On the left side the arrangement of these bones is nearly the usual one among the *Cervidæ*. That is to say, the cuboid and navicular are fused into one bone, the second and third cuneiforms into another, but, strange to say, the first cuneiform is firmly ankylosed with the metatarsus, forming a little step against which the compound cuneiform abuts. In the right foot the process of ankylosis has gone further and gives a tarsus which is even more concentrated than in the Tragulina. (See fig. 7). The compound cuneiform is fused with the cubo-navicular (fig. 7, *N.* and *Cb.* and *C.*, 2 and 3), and the first cuneiform, as in the left foot, with the metatarsus (fig. 7, *C* 3). This fusion of tarsal bones with the metatarsus is very curious. It does not occur in any known ungulate, and I am acquainted with no other mammal in which it can be found. A tarso-metatarsus, in the same sense, but to a less degree, as in birds, is thus formed.

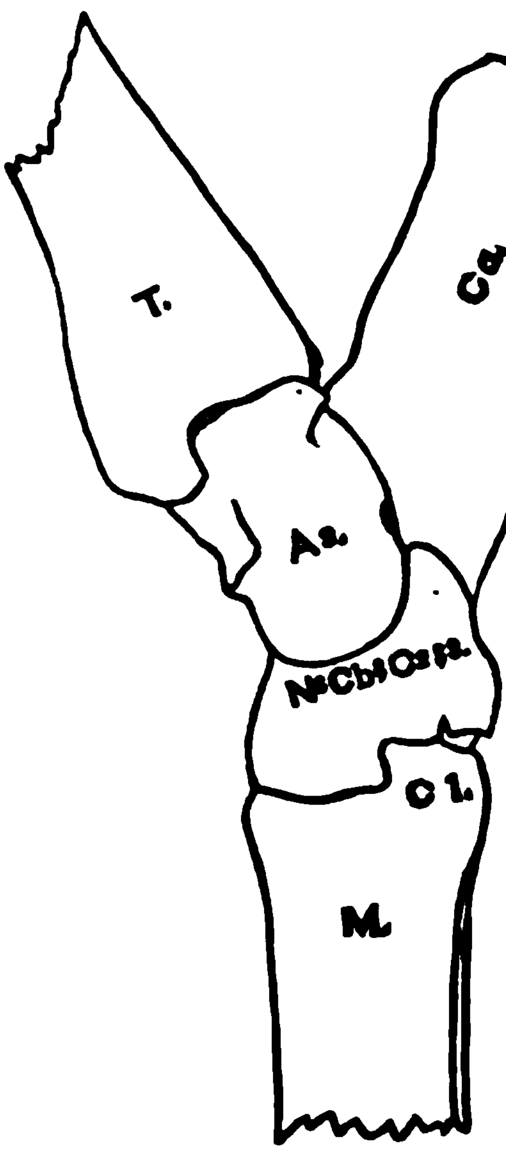


Fig. 7.

Right Tarsus of *Cervalces Americanus*.

The *Metatarsus* is very long, and of about the same proportions as in the moose.

The *Phalanges* of the median digits are a little longer than in the fore-foot, those of the rudimentary digits of about the same size.

Conclusion.

Cervalces Americanus is a very interesting form, and offers some morphological suggestions of great value. Geologically it teaches little that was not known. Its occurrence so far south of the moose's range, points to a colder climate than the present,

though the perfect preservation and freshness of the bones in the Princeton skeleton make it hard to believe that they are more than a few years old.

In all probability the habits of the animal, and to a great degree its appearance, were those of the moose. Its short neck shows that it would have great difficulty in grazing, and so probably lived by browsing upon shrubs and trees. This was aided, no doubt, by a more or less prehensile upper lip, which the character of the nasal opening shows to have been more proboscis-like than in the deer, though far less so than in the moose.

Morphologically the fossil is of interest for the light which it seems to throw upon the question of the origin of the genus *Alces*, and its relations to the typical deer. Sir Victor Brooke and Prof. Garrod have shown that the *Cervidæ* may be subdivided into great groups according to the characters of the skull and fore-feet. According to the latter we have the Plesio- and Telemetacarpi, or those which retain the proximal and distal ends of the metacarpals respectively. With one exception, *Cervus canadensis*, all American deer are Telemetacarpi, while nearly all of the Old World deer are Plesiometacarpi. Those of circumpolar range, the reindeer and moose, are both Telemetacarpi. Another distinction is found in the structure of the skull. In one division, the American deer (except *C. canadensis*), the vomer reaches the palatines and projects beyond them, dividing the posterior nares into two. The Old World deer have a vomer that does not reach the palatines, and the posterior nares are not divided. In *Alces* we have the latter type of skull.

The chief differences between the true *Cervus* and *Alces* are as follows: (1) The former is plesio-, the latter tele-metacarpal, both agreeing in the structure of the nasal passages. (2) *Cervus* has cylindrical antlers, with brow- and bez-tines rising abruptly from long pedicels. *Alces* has palmated antlers, without brow- or bez-tines, the beam directed horizontally from the short pedicels. (3) In *Alces* the nasals are very short, the anterior nares of great extent; in *Cervus* the nasals are long, and the anterior nares small. (4) In *Alces* the premaxillæ are imbedded in a groove of the maxillæ, and do not reach the nasals; in *Cervus* they lie external to the maxillæ, and (in some species at least) do reach the nasal. (5) In *Alces* there is a deep notch on the supra-

occipital, and a prominent knob on the frontal ridge, neither of which is present in *Cervus*. (6) In *Cervus* the skull is short and broad, and the diastema of moderate length; in *Alces* the skull is long and narrow, and the diastema very long. (7) In *Cervus* the tympanic bulla is inflated; in *Alces* not. (8) *Cervus* has a horizontal zygoma; in *Alces* it is directed downwards and forwards. (9) *Cervus* possesses canine teeth in both sexes; *Alces* in neither. (10) *Alces* has a short neck and trunk, long limbs and head; *Cervus* has longer neck and trunk and shorter legs. (11) In *Alces* there is a proboscis-like upper lip and almost obsolete rhinarium; *Cervus* has larger rhinarium and ordinary snout. In nearly all of these particulars, *Alces* is plainly a greater departure from the ordinary cervine type than is *Cervus*, and must, therefore, be regarded as a more differentiated and highly specialized form. If this be the case, we should naturally conclude that *Alces* is the descendant of some form much more closely allied to *Cervus* than itself is. That the descent cannot be from the actual genus *Cervus* seems to be plain from the character of the fore-foot. A reasonable inference seems to be that the common ancestor of the two genera had already attained the structure of skull found in the Old World deer, but that its fore-feet were tetradactyl, the lateral metacarpals, though slender, were complete or nearly so in length.

Now *Cervalces* throws some light upon this community of origin and subsequent divergence of the two genera. In many respects, as we have already seen, *Cervalces* differs very decidedly from *Alces*, and nearly all these differences are approximations to the structure of *Cervus*, a result which can hardly be accidental. But except in the skull, the structure of the fossil form is much nearer to that of *Alces*. The fossil agrees with *Alces:* (1) In the short neck and trunk and very long legs; (2) in being telemetacarpal; (3) in having palmated antlers; (4) in the absence of an inflated tympanic bulla; (5) in the shape of the zygoma; (6) in the absence of canine teeth.

On the other hand it agrees with *Cervus:* (1) In the presence of the bez-tine (?) and posterior tine on the antlers; (2) in having long nasals; (3) in the shape and relations of the premaxillæ; (4) in the absence of the supra-occipital notch and knob on the frontal ridge; (5) in the greater proportionate breadth of the

skull; (6) *Cervalces* almost certainly had a rhinarium and upper lip more like that of *Cervus* than of *Alces*.

Cervalces differs from both genera: (1) In the intermediate condition of the anterior nares; (2) the peculiar antlers; (3) the distinct prefrontals; (4) the remarkable concentration of the tarsals.

It thus seems very probable that *Alces* is descended from a type with limbs, skull and antlers of the ordinary type and with tetradactyle fore-feet, but has modified these in various ways. The length of limb seems to be connected with the habitat of the animal in snowy regions, and we are told that the moose can make his way with great swiftness through snow-drifts that will engulf ordinary cattle. The unusual size of the lateral digits seems to have reference to the animal's habit of living in swampy lands during the summer, and so needing a broad surface to prevent sinking in the mud. The shortening of the neck is difficult to account for, but the proboscis-like upper lip seems to be clearly connected with the habit of browsing upon trees. Shortening of the neck is very generally associated with the development of a prehensile lip; *e. g.*, the combined length of head and neck in the rhinoceros is relatively greater than in the tapir.

Cervalces seems to have been a contemporary of the moose which also occurs in quaternary deposits, though in all probability the former is the older of the two. Its extinction may be referred to the general causes which destroyed so many of the large quaternary mammals, though the competition of the more perfectly adapted moose may have had something to do with it.

Whatever taxonomic value be allowed to the peculiarities of this strange fossil, the fact remains that in it we can catch some glimpse of the successive steps by which the remarkable genus *Alces* has originated.

Measurements.

	Alces.	*Cervalces.*	*Megaceros.*
	M.	M.	M.
of trunk from 1st rib to end of um,	1·478	1·550	1·683
f thorax,	·708	·755	·840
f lumbar region,	·440	·435	·444
f sacrum,	·235	·225	·241
f neck,	·515	·563	·756
f skull,	·550	·536	·453
of forehead,	·205	·255	·220
between burrs of antlers,	·165	·234	·120
f nasals,	·108	·181	·170
nares from nasals to tip of premax.	·285	·185	·120
antlers,	1·175	1·620	2·260
f antler, measured along outside s,	·925	·868	1·702
f pedicels,	·030	·028	·048
height at withers,	1·695	1·810	1·890
t sacrum,	1·565	1·680	1.610
t occiput,	1·610	1·790	1·940
t tip of antler,	2·258	2·342	2·740
f fore-leg (straight line),	1·565	1·685	1·620
f scapula,	·443	·443	·455
f humerus (fr. tuberosity),	·405	·425	·375
f radius,	·415	·450	·378
f carpus,	·043	·055	·045
f metacarpus (outside),	·318	·355	·324
f phalanges,	·193	·225	·188
rence of humerus, (below exter. r.),	·175	·185	·200
rence of radius,	·132	·140	·145
rence of metacarpus,	·118	·132	·135
f hind-leg (straight line),	1·450	1·477	1·360
f femur (from head)	·435	·440	·435
f tibia,	·485	·512	·450
f tarsus,	·097	·117	·114
f metatarsus,	·385	·421	·348
f phalanges,	·213	·234	·197
rence of femur,	·147	·165	·180
rence of tibia,	·175	·170	·190
rence of metatarsus,	·135	·147	·150
dorsal spine,	·283 3d	·290 3d	·307 (8th)
rence 4th cerv. vertebra,	·340	·373	·490
rence of last lumbar (incl. spine),	·290	·295	·375
of pelvis,	·501	·490	·520
rib from tubercle),	·538 8th	·550 8th	·610 (9th)

l be noticed that the dimensions here given for *Megaceros*, are taken from a skeleton in the Princeton Museum, are fferent from those given by Owen in his "British Fossil als." The discrepancy is largely due to different methods nting.

EXPLANATION OF FIGURES AND PLATE.

Fig. 1. Side view of skull of *Cervus canadensis.*

Fig. 2. Side view of *Cervalces americanus.*

Fig. 3. Side view of *Alces machlis.*

References for figs. 1–3.—*Fr.*, frontal; *N.*, nasal; *Tb.*, turbinal; *Pmx.*, premaxilla; *M.*, maxilla; *Pf.*, prefrontal (?); *O.*, orbit; *A. O.*, ante-orbital vacuity.

Fig. 4. Skull and antlers of *Megaceros hibernicus.*

Fig. 4 *a.* Right antler of *Megaceros hibernicus,* from the inside (from Owen, British Foss. Mam. and Birds, fig. 186, p. 456).

Fig. 5. Skull and antlers of *Cervalces americanus.*

Fig. 6. Skull and antlers of *Alces machlis.*

References for figs. 4–6.—*Br.*, brow antlers; *Bz.*, bez-tine; *P.T.*, posterior tine (as of Brooke's system); *A.*, anterior division of main antler; *P.*, posterior division of main antler.

Fig. 7. Right tarsus of *Cervalces americanus.* *T.*, tibia; *Ca.*, calcaneum; *As.*, astragalus; *N, Cb. & C* 2 & 3, compound bone formed by fusion of cuboid, navicular, second and third cuneiforms; *Cl*, first cuneiform, fused with metatarsus; *Mt.*, metatarsus.

Plate II.

Skeleton of *Cervalces americanus* (from a photograph). The scale is in feet, and tenths of feet.

I wish to express here my obligations to Dr. F. C. Hill, Curator of the Museum, for his invaluable assistance in this work. I am indebted to him for the drawings of Figs. 1, 2, 3 and 7.

DESCRIPTIONS OF NEW SPECIES OF PARTULA AND A SYNONYMIC CATALOGUE OF THE GENUS.

BY WM. D. HARTMAN, M. D.

Partula Magdalinæ, nobis.

Shell short, conic, dextral, inflated, thin and fragile; spire short, half the length; umbilicus somewhat compressed; whorls 4½, apical whorls very thin, rounded and sub-transparent, with

the embryonic lines of fovea deeply impressed, which become numerous waved spiral striæ, decussated by fine oblique lines of growth, causing a granulated appearance of the surface; body-whorl much inflated, with the basal half thickened and rounded; columella wide at the base, and nodulose; color white, epidermis thin, pale green, in bands on the basal half; aperture perpendicular, large, rounded ovate, lip thin, white, concave and reflected.

Length 10, width 11 mill.; aperture, length 8, width 5 mill.

Hab.—Magdalena Island, Marquesas.

Obs.—I am indebted to Mr. Andrew Garrett, of Huaheine, for four examples of this shell; it is about the size of *P. decussatula*, but more inflated, thinner, with a short, and less acute spire. Like *P. Ganymedes* and *P. inflata*, from Marquesas, the basal half of the shell is thicker and more opaque than the superior part.

Partula bellula, nobis.

Shell abbreviately ovate, dextral, umbilicate, thin, translucent;

whorls 5, rounded, suture impressed, apex acute, spiral striæ decussated by coarse oblique lines of growth, giving the surface a waved appearance; aperture perpendicular, round-ovate, columella wide at the base, lip thin, white, reflected; color pale straw, with the apex very pale rose.

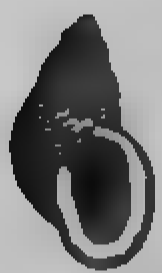
Length 15, width 9 mill.; aperture, length 7, width 4 mill.

Hab.—Wapo Island, Marquesas.

Obs.—Mr. A. Garrett collected one example of this pretty species on Wapo, at an altitude of 2500 feet above sea-level. A similar shell, sent by him to the Museum Godeffroy, was found at Dominique at the same altitude.

Partula Tryoni, nobis.

Shell acuminately oblong, dextral, moderately thick, rimate perforate; whorls 5, rounded, body-whorl equal to the spire, oblique lines of growth coarse, spiral striæ almost obsolete; color pale fawn, with white oblong, interrupted, lime-like dots, in oblique rows, in the substance of the shell; aperture perpendicular, ovate, with a nacreous deposit connecting the margins of the peritreme, lip white, flat, and broadly expanded.



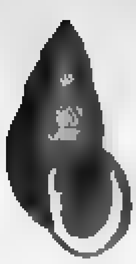
Length 21, width 12 mill.; aperture, length 9, width 4 mill.

Hab.—Solomon Islands.

Obs.—For one example of this fine species I am indebted to Mr. Garrett, who received it from our mutual friend, Dr. Cox, of Sydney, Australia. Like *P. actor* Albers, *zebrina* Gould, it possesses the lime-like deposit in the substance of the shell. It is a larger and more oblong shell than the latter, but like it, has a broadly reflected flat lip.

Partula flexuosa, nobis.

Shell acuminately oblong, flexuose, dextral, umbilicate, thin and semi-transparent; whorls 5, slightly rounded, spiral striæ numerous and very fine; body-whorl half the length, slightly compressed at base; color light brown or ash; aperture oval, slightly oblique, lip concave and reflected, with a very thin deposit connecting the margins of the peritreme.



Length 15 to 20, width 8 to 9 mill.; aperture, length 7 to 8, width 4 mill.

Hab.—St. George's and Eddystone Islands, Solomon Islands.

Obs.—Several examples of this shell, from Dr. Cox and Mr Garrett, have been in my possession for a long time, and I hesitate to describe them, supposing they might be *P. cinerea* Albers. Dr. Cox having kindly sent me all his collection of Partula, for examination, I found the same shell amongst others from Eddystone and St. George's Islands. Some examples are thin and quite flexuose, while others are stouter and more direct.

Partula glaber, nobis.

Shell acuminately oblong, dextral, somewhat inflated, translucent, rimate-perforate; spire more than half the length; whorls 6, slightly convex, smooth, oblique lines obscure, spiral striæ absent, except the spiral fovea on the two apical whorls; a white fillet beneath the suture; aperture widely oval, perpendicular, lip slightly reflected, columella expanded at base, of a pale rose color, staining the umbilicus; color white, aperture a very pale rose, with the apex dark purple.

Length 21, diam. 10 mill.; aperture, length 10, diam. 5 mill.

Hab.—?

Obs.—This pretty species was received amongst other shells as *P. turricula* Pease, New Hebrides (?), without a voucher. A comparison with the description of *turricula* disproves its identity with that species. It is very distinct from any Partula with which I am acquainted.

Synonymic Catalogue of the Genus Partula.

In the year 1881 I published a catalogue of the genus *Partula*, Férussac, in which I proposed several sub-genera. These were subsequently withdrawn in consequence of not possessing sufficient distinctive characters. In the present list I have arranged the species in groups, designating each by the name of a well-known species, which, in most instances, typifies its general characters and facies. Hybridization is probably a factor in the variability of some species, which may account for the confusion of their synonymy. Owing to similarity of general appearance, it is often difficult to recognize a species by the diagnosis, when unaided by figures. Since the publication of my Bibliographic Catalogue of Partula, in 1881, I have embraced every opportunity to perfect my list, in which I have been aided by a number of friends. To Capt. Jno. Brazier, C. M. Z. S., and Jas. C. Cox, M. D., C. M. Z. S., I am indebted for correct localities of the species from New Hebrides and Solomon Islands, as well as for examples from several habitats on those groups. To the generosity of Mr. Andrew Garrett, of Huaheine, I am indebted for several new species. When in London in 1883, I was unable to inspect the Cumingian Collection, which was boxed preparatory to its

removal to the New Kensington Museum of Natural History. By the kindness of E. A. Smith, F. Z. S., some of my species have been compared with those in the British Museum, which has partly atoned for this disappointment. I am indebted to the politeness of Dr. Paul Fischer and Dr. A. T. de Rochebrunne, of the Jardin des Plantes, for affording me every facility in the examination of the Partulæ in the Museum.

All species marked with a dagger (†) are embraced in my collection.

Genus **PARTULA**, Fér.

Auriform Division.

I. *Faba Group.*

† **P. faba** Martyn (Limax), Univers. Conch., vol. 2, p. 667, figs. 78, 79, 80, vars. *Raiatea.*

Limax faba Chenu. Bib. Conch., ii, p. 24, pl. 24, f. 2 *a*.
Helix faba Gmel., p. 3625 ; Wood, Index, p. 33, fig. 47. Linn., Dill., Mull.
Helix substriata Gmel., p. 3437, n. 11.
Otis faba Humph.
Auris Midæ fasciata Chemn. Conch., tab. 141, fig. 1041.
Voluta auris malchi, var., Gmel., p. 3437.
Voluta fasciata Dill. Des. Cat., p. 502, Id. *Helix faba*, p. 906.
Bulimus Australis Brug. Enc. Meth., i, p. 347. Desh.
Bulimus inconstans and *tricolor* Muhlf. Teste Anton, Verz., p. 40.
Bulimus faba Albers.
Partulus Australis Beck. Ind. Moll., p. 37. Albers.
Partulus bulimoides Fér.
Partulus bulimoides Pfr. Mon. Hel. Viv., 302 (non Lesson).
Partula Australis Fér. Prod., p. 66, n. 2.
† *Partula faba* Sowb. Rve., Pfr., Woodw., Chenu, A. Adms., Pse., Päet., Schm., Hartm., Garr.
† *Partula faba*, var. *subangulata*, Pse. Jour. Conch., 491. Hart., Garr.
† *Partula ventricosa* Pse. MS. Coll. Pse., Hartm., Garr.
† *Partula amanda* Garr. MS. Hartm.
† *Partula dubia* Garr. MS. Hartm.
† *Partula marginata* Garr. MS. Hartm.
Partula bella Pse. MS. Ex. in A. N. S. ex auctore. *Raiatea.* Non *bella* Pse. in P. Z. S., p. 473, 1871. Hartm., Garr.
† *Partula brunnea* Pse. MS. Coll. Pse., Hartm., Garr.
† *Partula pallida* Pse. MS. Coll. Pse., Hartm., Garr.
† *Partula biangulata* Pse. MS. Coll. Pse., Hartm., Garr.
† *Partula propinqua* Pse. MS. Coll. Pse., Hartm., Garr.
† *Partula ventrosa* Auth. MS. Coll. Pse., Hartm.
Partula marginata Garr. MS.

† **P. citrina** Pse. A. J. C., ii, p. 195, 1866. *Raiatea.*

P. citrina Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 6, pl. 3, fig. 52. Schm., Pfr.
P. citrina Pfr. Mon. Helic. Viv., p. 302.
P. faba, var., Carpt., Hartm.

Obs.—In common with Pse., Cuming and Pfr., in former catalogues, I regarded this shell as a variety of *faba*. Other varieties of *faba* are equally constant in color, but less abundant. I defer to the opinion of Mr. Garrett, who is fully convinced of its specific value, having collected it in great quantity.

† **P. vittata** Pse. A. J. C., p. 194, 1866. *Raiatea.*

P. vittata Garr. Terr. Moll. Soct. Isls., J. A. N. S., vol. ix, p. 75, pl. 3, fig. 56.
P. vittata Pfr. Hartm.
† *P. terrestris* Pse. MS. Coll. Pse., Päetl., Gloy., Hartm., Garr.
† *P. castanea* Pse. MS. Coll. Pse., Hartm., Garr.
† *P. approximata* Pse. MS. Coll. Pse., Schm., Gloy., Hartm., Garr.
P. faba, var., Carpt. P. Z. S., p. 675, 1864.
† *P. microstoma* Pse. MS. Coll. Pse., Hartm. (non Garr.).
P. vittata Pfr. Mon. Helic. Viv., p. 302.

Obs.—Mr. Garrett very properly unites the three MS. varieties of Mr. Pease, *terrestris*, *castanea* and *approximata*, with *vittata*, of which they are modified forms. *P. microstoma* Pse. MS., Coll. Pse., are large examples of *vittata* without the pillar tooth. *P. microstoma* Pse., is certainly not synonymous with *P. radiata* Pse. MS.

† **P. fusca** Pse. A. J. C., p. 193, 1866. *Raiatea.*

P. fusca Päetel. W. G. Binn., Pfr., Schm., Hartm.
P. fusca Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 71, pl. 3, fig. 50.
P. ovalis Pse. A. J. C., ii, p. 194, 1866. Pfr., Hartm. (non Garr.).
P. dentifera Carpt. = *ovalis* (non Pfr.).
P. faba, var., Carpt. P. Z. S., p. 675, 1864 = *protea*.
P. protea Pse. MS. Coll. Pse., Schm., Pfr., Hartm. (non Garr.).
P. navigatoria Carpt. (non Pfr.).

Obs.—In former catalogues I included all the variable terrestrial species, *lugubris*, *protea*, *ovalis* and *fusca*, under *fusca*. The type examples of *fusca* (Coll. Pse.) are immature shells of the uniform dark fuscous *ovalis*, two quarts of which were included in the Pease duplicates, labeled *P. ovalis* by Pease. The shell

is solid, of a uniform dark chestnut-brown or fuscous color, with a white expanded lip, and the pillar tooth is absent. I have seen several suites labeled *fusca*, from the hands of Mr. Pease, in which the banded *ovalis* and *protea* predominated. His description calls for "an edentate shell, of a wholly dark chestnut color, or with an occasional light band encircling the last whorl, or yellowish striped longitudinally and irregularly with chestnut, and the lip stained with brownish purple." Mr. Garrett's fig. = *protea*, as it possesses the denticle and peripheral band. There is considerable variation in my suites of this shell, which may eventually result in its being divided into two species.

† **P. lugubris** Pse. P. Z. S., p. 672, 1864. *Raiatea.*

P. lugubris Pfr. Schm., Garr., Hartm.
P. ovalis Garr. Hartm. (non Pse.).
P. fusca Hartm. (non Pse.).

Obs.—I have followed Mr. Garrett in separating *lugubris* from *fusca*. *P. lugubris* is certainly not *Pacifica* Pfr. (E. A. Smith).

† **P. Navigatoria** Pfr. (Bulimus), Mon., iii, p. 449. *Raiatea.*

P. Navigatoria Rve. Mon. Part., tab. 4, fig 21.
P. Navigatoria Carpt. Hartm., Garr.
P. variabilis Pse. A. J. C., ii, p. 208; Id., p. 81, pl. 1, f. 13-15, 1866-67.
P. variabilis Pfr. Schm., Paetel., Hartm.

Obs.—A comparison of examples with Pfeiffer's types in the British Museum, establishes the fact that these species are synonymous. As *variabilis* is found only on the island of Raiatea, and not at the Navigator Islands, the former is a misnomer, and the name of Mr. Pease should be retained for the species.

† **P. radiata** Pse. MS. Type in A. N. S., ex auctore. *Raiatea.*

P. radiata Garr. Terr. Moll. Society Isls., J. A. N. S., vol., ix, p. 74, fig. 45.
P. radiata Hartm. Ancey.
P. compressa Carpt. (non Pfr.). Pse., Schm.
P. microstoma Garr. (non Pse.).
P. vittata Garr. (non Pse., Hartm.).

Obs.—This shell has been disseminated by Pease and the Museum Godeffroy as *compressa* Pfr., an error which I corrected in my Bibliographic Catalogue of the Genus Partula, and which was subsequently noted by Mr. Ancey.

† **P. planilabrum** Pse. P. Z. S., p. 672, 1864. *Tahaa.*

P. planilabrum Pfr. W. G. Binn., Schm., Hartm., Garr.
P. suturalis Pse. MS. (non Pfr.).

Obs.—The dark variety with white suture is the Pease type of *suturalis*, MS. *P. suturalis* Pfr., in the British Museum = *alternata* without bands.

II. *Auriculata Group.*

† **P. auriculata** Brod. P. Z. S., p. 33, 1832. *Raiatea.*

Bulimus auriculatus Pfr., 1841. Jay, Cat., p. 204.
Partulus auriculatus Beck, Index.
Partula Otaheitana Rve. Mon., pl. 2, fig. 11 *a*, 11 *b*.
Partula Otaheitana Pfr. Mon. Helic. Viv., p. 302.
Partula robusta Pse. MS. Coll. Pse., Hartm.
Partula solidula Pse. MS. Coll. Pse.
Partula auriculata Müll. Carpt., Päetel, Schm., Hartm., Garr.

Obs.—Owing to the variable size and coloration of this species, some of the old authors confounded this shell with *Otaheitana* Brug., from which it is very distinct.

† **P. bilineata** Pse. A. J. C., p. 201; Id., p. 81, pl. 1, fig. 10, 1866–67. *Tahaa.*

P. bilineata Wm. G. Binn. Pfr., Gloy., Schm., Hartm., Garr.
P. auriculata Carpt. (non Brod.).

† **P. compacta** Pse. A. J. C., ii, p. 200; Id., iii, p. 81, pl. 1, fig. 9, 1866–67. *Raiatea.*

P. compacta Päetel. Schm., Pfr., Hartm., Garr.
P. auriculata, var., Carpt.
P. callifera Gloyne (non Pfr.).

Obs.—Mr. E. A. Smith writes: "This shell agrees exactly with *solidula* in the British Museum, except that *compacta* possesses a denticle."

† **P. thalia** Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 69, fig. 46. *Raiatea.*

P. abbreviata Pse. MS. Coll. Pse. (non Mouss.).
P. auriculata, var., Carpt. P. Z. S., p. 675, 1864.
P. Peaseiana Garr. MS. (non *Peasei* Cox).
P. Thalia Garr. MS. Hartm.
P. solidula Küst. See fig. (non Pfr.).

Obs.—This shell has been distributed as *abbreviata* Pse.

III. *Dentifera Group.*

† **P. dentifera** Pfr. P. Z. S., p. 65, 1852. *Raiatea.*

P. dentifera Chemn. T. 44, figs. 14, 15.
P. dentifera Pse. Carpt., Schm., Hartm., Garr.
P. decorticata Pse. MS. Coll. Pse., Hartm.
P. recta Pse. MS. (Non *recta* Pse., in A. J. C.) Hartm.
P. Raiatensis Garr. MS. Exemp. ex auctore. Hartm., Bib. Cat., p. 186.
P. labiata Pse. MS. Coll. Pse., Hartm., Päetel., Schm., Pfr.

Obs.—My examples of *Raiatensis* from Mr. Garrett are much smaller than *imperforata* Pse., to which he has recently referred it. See Obs. on the Pease duplicates, Bibliographic Catalogue, p. 194.

† **P. callifera** Pfr. P. Z. S., p. 333, 1856. *Raiatea.*

P. callifera Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 60, fig. 82.
P. callifera Carpt. Pse., Hartm.
P. megastoma Pse. MS. Schm.
P. callistoma Schm.

† **P. formosa** Pse. MS. Coll. Pse., Hartm. *Raiatea.*

P. formosa Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 60, pl. 3, fig. 49.
P. formosa Hartm.

† **P. imperforata** Pse. MS. Coll. Pse., Hartm. *Raiatea.*

P. imperforata Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 54, pl. 3, fig. 53.
P. imperforata Päetel. Pfr., Hartm.
P. dentifera Carpt. (non Pfr.).
P. recta Pse. MS. Coll. Pse. (non *recta* Pse. in A. J. C.).
P. auriculata var. Carpt. P. Z. S., p. 675, 1864.
P. Raiatensis Garr. MS. (non Hartm.).

† **P. virginea** Pse. MS. Coll. Pse., Hartm. *Tahaa.*

P. virginea Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 61, pl. 3, fig. 54.
P. virginea W. G. Binn. Schm., Hartm.
P. solidula, var., Carpt. P. Z. S., p. 675, 1864.

† **P. lutea** Lesson. Voy. Coq., p. 325, 1856. *Bora-bora Islands.*

Bulimus luteus Desh. Pfr.
Partula lutea Pfr. Pse., Hartm.
P. solidula Schm. (non Rve.).
P. lilacina Pfr. Pse., Hartm.

Obs.—The type *lilacina* is an example denuded of epidermis,

exhibiting the lilac color of the shell beneath. The locality, Marquesas, is probably an error.

† **P. Garrettii** Pse. P. Z. S., p. 672, 1864, p. 473, 1871. *Raiatea.*

P. Garrettii Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 56, pl. 3, fig. 48.
P. Garrettii Pfr. Schm., Hartm.
P. gonocheila Schm. (non Pfr.).

IV. *Umbilicata Group.*

† **P. umbilicata** Pse. A. J. C., ii, p. 200, 1866; Id., iii, p. 81, pl. 1, fig. 7, 1867. *Tahaa.*

P. umbilicata Päetel. W. G. Binn., Schm., Hartm., Garr.
P. auriculata, var., Carpt.

† **P. gibba** Fér. Prodr., p. 66, No. 66. *Guam Island.*

P. gibba Rve. Con. Icon., Monog. Part., fig. 15 *a*, 15 *b*.
Helix gibba Quoy.
Bulimus gibbus Desh. Chemn.
Partula gibbus Beck.
Partula mastersi Pfr. Hartm.

† **P. bicolor** Pse. P. Z. S., p. 473, 1871. *Guam Island.*

P. bicolor Pse. A. J. C., vii, p. 26, pl. 9, f. 4, 1872.
P. bicolor Hartm. Bib. Cat., p. 180, 1881.

† **P. crassilabris** Pse. A. J. C., ii, p. 199; Id., iii, p. 81, pl. 1, f. 6, 1866–67. *Raiatea.*

P. crassilabris Schm. Pfr., Hartm.
P. Otaheitana Rve. (Non Brug.) *Raiatea.*
P. Hebe, var., Carpt.
P. rustica Pse. A. J. C., ii, p. 199; Id., p. 81, pl. 1, fig. 5.
P. rustica Schm. Pfr.
P. auriculata Carpt. (non Brod.).
P. crassilabris Gloyne. Hartm.
P. pinguis Garr. MS. Hartm.

Obs.—I do not agree with Pease and others in separating this variable terrestrial form into two species. See Bibliographic Catalogue Partula, page 187.

† **P. Hebe** Pfr. (Bulimus). P. Z. S., p. 39, 1846. *Raiatea.*

Bulimus Hebe Chemn.
Partula Hebe Pfr. Rve., Pse., Päetel, Schm., Hartm., Garr.
Partula globosa Pse. MS. Coll. Pse., Hartm., Gloyne, Schm.
Partula ventricosa Garr. MS. Hartm.
Partula Hebe, var. *bella*, Pse. P. Z. S., p. 473, 1871.

V. *Expansa Group.*

† **P. expansa** Pse. A. J. C., p. 26, pl. 9, f. 3, 1871. *Tutuila.*

P. extensa Pse. P. Z. S., p. 473, 1871 (error for *expansa*).
P. extensa Pfr., viii, p. 204. Nom. Helic. Viv., 302.
P. extensa Hartm. Bib. Cat. Part., 182.

Obs.—In Europe this shell is usually mistaken for *zebrina* Gld.

† **P. Peasei** Cox. P. Z. S., p. 644, pl. 52, f. 2, 1871. *Malayta Island, Solomon Islands.*

P. Peasei Pfr., vi, 48. Nom. Helic. Viv., 303.
P. Peasei Hartm. Bib. Cat. Part., 185.

Obs.—I am indebted to Dr. Cox for this extremely rare shell. This group does not approximate in structure any other species except *umbilicata;* they have been placed here provisionally, the anatomy of the animal may confer upon them another status.

VI. *Otaheitana Group.*

† **P. Otaheitana** Brug. (Bulimus). Ency. Meth., i, p. 347, No. 64, 1792. *Tahiti.*

Bulimus Otaheitanus Desh. Lam., Küst., Pfr.
Bulimus amabilis Pfr.
Bulimus Isabellinus Pfr.
Bulimus laevis Gray.
Bulimus auriculatus Pfr.
Helix perversa Chemn.
Helix Otaheitana Dillw.
Helix laevis ? Wood.
Partulus Otaheitanus Beck. Albers.
Partulus Vanikorensis Beck.
Partulus auriculatus Beck.
Partula Otaheitana Fér. Grat., Rve., Jay, Pfr., Päetel, Hartm., Garr.
Partula Vanikorensis Lam. Pfr., Gld., Päetel, Hartm., Garr. (non *P. Vanikorensis* Quoy and Gaim. (Helix).
† *Partula Isabellina* Rve. Pfr., Päetel, Hartm., Garr.
† *Partula amabilis* Pfr. Rve., Pse., Päetel, Gloyne, Hartm., Garr.
† *Partula rubescens* Rve. Pfr., Pse., Hartm., Garr.
† *Partula Reeveiana* Pfr Chemn., Hartm., Garr.
Partula Tahitana Gld. Pse., Schm., Hartm., Garr.
Partula Taheitensis Päetel.
Partula Tahutana Antbn. Hartm.
Partula lignaria Garr. (non Pse., Pfr., Chemn., Hartm.).
Partula affinis Garr. (non Pse., Pfr., Schm., Hartm.).
Partula rufa Carpt. Hartm. (non Less.).

† *Partula sinistorse* Pse. MS. Coll. Pse., Päetel, Schm., Pfr., Gloyne, Hartm., Garr.

Partula sinistralis Pse. MS. Coll. Pse., Päetel, Pfr., Hartm., Garr.

† *Partula crassa* Pse. MS. Coll. Pse., Hartm., Garr.

† *Partula perversa* Pse. MS. Coll. Pse., Hartm., Garr.

† *Partula turricula* Pse. MS. Coll. Pse. (non *turricula* Pse., in A. J. C., 1872), Hartm., Garr.

Partula varia Carpt. (non Brod.).

Partula Pacifica Pfr. Hartm.

Partula diminuta C. B. Adms. Hartm.

Obs.—From the list of synonyms attached to this variable shell, it would seem that for many years it has been regarded as "a refuge for the destitute."

P Vanikorensis Quoy and Gaim. (Helix). Voy. Astrolabe, ii, p. 115, pl. 9, fig. 12–17, 1830. *Vanikoro Island.*

Bulimus Vanikorensis Lam., Pfr.

Partulus Vanikorensis Beck.

Partula Vanikorensis Pfr. Päetel, Hartm., Garr.

Obs.—In former catalogues I followed Dr. Gould, who placed this species as a synonym of *Otaheitana* Brug. After an examination of the types of Quoy and Gaimard, in the Collection of the Jardin des Plantes, Paris, I cannot but restore the species. The shell is thinner than *Otaheitana*, of a uniform pale red color, with the apical whorls inflated and rounded. In collections it is usually represented by *Otaheitana*, *affinis*, and *stolida*.

† **P. lineata** Lesson (Bulimus). Voy. Coquille, p. 324, figs. 8–9, 1826. *Oualan Island.*

Partulus torosus Beck.

Partula lineatus Albers.

Partula lineata Hartm. Bib. Cat., p. 188.

Obs.—Lesson's figure is so very different from that of Mr. Reeve, that for the present I am inclined to keep the species separate, notwithstanding Captain Brazier writes, "that he crossed the Island of Oualan twice, without finding it." Mr. Reeve first confounded it with *vexillum* Pse. Mr. E. A. Smith writes, "*Vexillum* Pease is not *lineata* in the British Museum," and he believes that "Reeve's determination of *vexillum* = *lineata* Less., is erroneous." Pease in the Smithsonian Collection says *lineata* = *elongata*. The latter is smaller, and wants the single narrow bright red band on the middle of the body-whorl. Lesson's figure is the size and outline of *P. producta* Pse., and like *producta* the denticle is absent on the pillar lip, both in his figure and description.

† **P. Mooreana** Hartm. Proc. A. N. S., p. 229, 1880. *Moorea, Marquesas.* Garr., Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 59, fig. 55, tab. iii.

† **P. lignaria** Pse. P. Z. S., p. 671, 1864. *Tahiti.*

P. lignaria Pfr. Schm., Päetel, Gloyne, Hartm. (non Garr.).
P. affinis Pse. Pfr., Schm., Hartm. (non Garr.).
P. nitens Pfr. Hartm.
P. rufa Carpt. Hartm. (non Lesson).
P. Otaheitana, var. *fasciata*, Fér. Coll. Jardin des Plantes.

Obs.—I do not assent to *lignaria* and *affinis* as synonyms of *Otaheitana*. See my Bibliographic Catalogue of Partula; pages 179 and 183. I possess numerous examples of all the varieties of this species; several are albinos, some are white with a brown band, var. *fasciata* Fér., others are dark brown with darker oblique striæ and a dark band at the periphery, var. *lignaria*. The variety *affinis* is always of a dark bay-brown, usually with darker oblique striæ and a smooth surface. All possess a button-like pillar tooth, and the base of the aperture has a looped appearance, which is a constant character of this shell. Some of the smaller examples of *Otaheitana* resemble it (probably the result of hybridization), but they may always be distinguished by the red color of the shell and lip. In most collections this shell is labeled *rufa*.

† **P. stolida** Pse. A. J. C., ii, p. 198, 1868. *Tahiti.*

P. stolida Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 70, pl. 3, fig. 58.
P. stolida Pfr. Hartm.
P. Vanikorensis Carpt. P. Z. S., p. 675, 1864 (non Quoy and Gaim.).

† **P. filosa** Pfr. P. Z. S., p. 262, 1851. *Tahiti.*

P. filosa Chemn. Hartm.
P. filosa Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 64.
P. lineolata Pse. A. J. C., p. 224, 1867. Schm., Pfr.

† **P. nodosa** Pfr. P. Z. S., p. 262, 1851. *Tahiti.*

P. trilineata Pse. A. J. C., iii, t. 1, f. 10, Pfr.
P. nodosa Hartm.
P. nodosa, var. *trilineata*, Pse.

† **P. producta** Pse. P. Z. S., p. 671, 1864. *Raiatea.*

P. producta Garr. Terr. Moll. Soct. Isls., J. A. N. S., vol. ix, p. 66, pl. 3, fig. 51.
P. producta Pfr. Schm., Hartm.

† **P. suturalis** Pfr. P. Z. S., p. 98, 1855. *Moorea.*

P. suturalis Pfr. Nov. Conch., vol. i, tab. 17, figs. 18–19.

P. stenostoma, Pfr. P. Z. S., p. 97, 1855. Hartm.

P. stenostoma. Nov. Conch., vol. i, tab. 17, figs. 16–17.

P. strigosa Pfr. P. Z. S., p. 384, 1856. Hartm.

P. vexillum Pse. A. J. C., ii, p. 198; Id., iii, p. 81, pl. 1, fig. 8, 1866–67. Hartm.

P. alternata Pse. MS. Coll. Pse., Hartm.

P. nodosa Carpt. (non Pfr.).

P. lineata Rve. Garr. (non Lesson).

Obs.—I agree with Mr. Garrett in combining all these variable shells from Moorea under one species, but I doubt if they = *lineata* Lesson. *Suturalis* and *strigosa*, in the Cumingian Collection, are only varieties of the Moorea shell; *stenostoma* and *suturalis* were described by Pfeiffer from examples in the British Museum, which are only varieties of *alternata* and *vexillum* Pease.

VII. *Tæniata Group.*

† **P. tæniata** Mörch (Bulimus). Cat. Conch. Kierulf., p. 29, pl. 1, fig. 5, 1840. *Moorea.*

P. tæniata Pfr., iii, p. 451. Carpt., Hartm.

P. spadicea Chenu, t. 64, fig. 31–32. Pfr., Rve., Hartm.

P. striolata Pse. A. J. C., ii, p. 197, 1866; iii, p. 81, pl. 1, fig. 4, 1867. Pfr., Hartm., Garr.

P. simulans Pse. A. J. C., ii, p. 202, 1866, p. 81, pl. 1, fig. 11. Pfr., Hartm., Garr.

P. elongata Pse. A. J. C., ii, p. 196, 1866; iii, p. 81, pl. 1, fig. 2, 1867. Pfr., Schm., Hartm., Garr.

P. Erhelii Morelet. J. Conchyl., t. 2, f. 7, 1853. *Moorea.* Pfr., Hartm.

P. nucleola Pse. MS. Coll., Pse., Hartm., Garr.

P. peraffinis Pse. MS. Pfr.

Obs.—Mr. Garrett very properly remarks, "this is truly a protean species." Of this fact I have been cognizant since I examined the duplicate collection of the late Mr. Pease. In six pints of duplicates from Moorea the connection between the varieties was readily traceable; on comparison "there is no difference between examples of these shells and those of *spadicea* in the British Museum, except that some are a trifle shorter." Mörch's habitat, *Fiji Isles*, for *tæniata*, is probably an error, as his examples "were purchased of a whale fisher." Pfeiffer, in the last edition of his Catalogue of Partula, says *peraffinis* Pse. MS. = *elongata* Pse.

† **P. clara** Pse. P. Z. S., p. 671, 1864. *Tahiti.*

P. clara Pfr. Hartm.

P. clara Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 56, pl. iii, fig. 75.

P. hyalina var.? Carpt. Pfr., Nom. Hel. Viv., p. 301.

P. micans Pfr. P. Z. S., p. 138, 1852. *Solomon Islands.*

P. micans Chemn. Tab. 66, figs. 12, 13.

P. micans Pfr. Nom. Helic. Viv., p, 303 (non Hartm.).

† **P. Carteriensis** Quoy and Gaim. (Helix). Voy. Astrol., ii, p. 117, pl. 9, fig. 10. *Carteret Island, N. Ireland.*

Bulimus Carteriensis Pfr., ii, 68. Desh.

Partulus Carteriensis Beck.

Partula Carteretensis Rve.

Partula Carteriensis Hartm. Pfr., Nom. Helic. Viv., p. 301.

† **P. hyalina** Brod. (Bulimus). P. Z. S., p. 32, 1832. *Tahiti, Maguaia Isld.,* Garr., Rurutu, Le Gage; *Tumaco* Cuming.

P. hyalina Pse., ii, p. 67. Chemn., t. 64, f. 19, 20.

Bulimus hyalinus Desh.

Partulus hyalinus Beck.

Partula hyalina Rve. Hartm.; Pfr., Nom. Helic. Viv., p. 301.

Obs.—This is the most widely distributed of any known species of Partula.

† **P. attenuata** Pse. P. Z. S., p. 672, 1864. *Raiatea, Tahiti.*

P. attenuata Pfr., iv, 507. Schm., Gloyne, Hartm., Garr.

P. gracilis Pse. A. J. C., p. 197, 1867; Id., p. 81, pl. 1, fig. 3.

P. gracilis W. G. Binn. Pse., Päetel, Hartm., Garr.

P. gracilior Pse. MS. Hartm., Ex. in A. N. S., ex auctore. *Isabel Island.*

P. Carteretensis Garr. (non Rve.).

Obs.—Mr. Garrett makes *Carteretensis* Rve. synonymous with this shell, to which I do not assent.

P. Hartmani E. A. Smith. P. Z. S., 1884. *Wild and Pigeon Islands.*

P. cinerea Albers. Mal. Blatt., p. 98, 1857. *Solomon Islands.*

P. cinerea Pfr., iv, 510. Hartm.

P. cinerea Pfr. Nom. Helic. Viv., p. 301.

† **P. lyrata** Mousson. Jour. Conchyl., xviii, p. 126, 1870. *Tavinu, Viti Isles.*

P. lyrata Hynem., in Mal. Blatt., xiv, t. 1, fig. 1 (Dentes). *Somma Island, Feejee Islds.*

P. lyrata Pfr., iv, 158; Hartm.; Pfr., Nom. Helic. Viv., p. 301.

† **P. flexuosa** Hartm. P. A. N. S., 1885.

† **P. lævigata** Pfr. P. Z. S., p. 334, 1856.

P. lævigata Pfr., iv, Hartm.; Pfr., Nom. Helic. Viv., 302.

P. grisea Lesson (Bulimus). Voy. Coquill., xiii, p. 325, pl. 13, f. 11, 1829. *New Guinea.*

Bulimus griseus Pfr.
Partulus griseus Alb.
Partula grisea Pfr., Nom. Helic. Viv., p. 301. Hartm.

† **P. concinna** Pse. A. J. C., vii, p. 196, 1872. *Tanna Island, New Hebrides.*

P. concinna Pfr., viii, 205; Pfr., Nom. Helic. Viv., p. 302. Hartm.

† **P. pellucida** Pse. P. Z. S., p. 457, 1871. *Guadelcanar Island, Solomon Islands.*

P. pellucida Pfr., viii, 199; Nom. Helic. Viv., p. 301.
P. micans Hartm.

Obs.—This shell was collected by Mr. John Brazier and presented to Mr. Pease. Heretofore I confounded this shell with *Coxi* Angas MS., and *micans* Pfr., it is smaller than either of the former and very thin and pellucid. It is the smallest Partula known.

† **P. Coxi** Angas MS. Cox, Cat. Land and Mar. Shells, Austr. and adjacent Islands, p. 46, 1868. *Isabel Isld., Solomon Isles.*

P. Coxi Hartm. Bib. Cat. Part., p. 181, 1881.

Obs.—Through the kindness of Captain Brazier, of Sydney, Australia, I have been presented with a number of examples from the original lot collected by himself. It is rather larger than *pellucida* Pse., more elongated; the aperture is also larger and more elongate, and the lip more expanded. The length of *pellucida* is 10 mill., while that of *Coxi* is 15 mill.

VIII. *Decussatula Group.*

† **P. decussatula** Pfr. (Bulimus). P. Z. S., p. 131, 1850. *Dominique Island, Marquesas.*

P. decussatula Rve. Mon. Part., Spec. 24, pl. 4, fig. 23, 1849.
P. decussatula Chemn., t. 65, figs. 8, 9. Hartm.
P. decussatula Pfr. Nom. Helic. Viv., p. 303.

† **P. Magdalinæ** Hartm. P. A. N. S., 1885. *Magdalena Isld., Marquesas.*

† **P. bellula** Hartm. P. A. N. S., 1885. *Wapo Isld. and Dominique, Marquesas.*

IX. *Turgida Group.*

† **P. turgida** Pse. (Bulimus). P. Z. S., p. 670, 1864. *Raiatea.*

P. turgida Hartm. Bib. Cat. Part., 188.
P. turgida Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 56, pl. 3, fig. 74.

† **P. annectens** Pse. (Bulimus). P. Z. S., p. 671, 1864. *Huaheine.*

P. annectens Pfr., vi, p. 48; Pfr., Nom. Helic. Viv., p. 303. Hartm.
P. annectens Garr. Terr. Moll. Society Isls., J. A. N. S., vol. ix, p. 66, pl. 3, fig. 70.

† **P. arguta** Pse. (Bulimus). P. Z. S., p. 670, 1864. *Huaheine.*

P. arguta Pfr., vi, 46; Hartm.; Garr., Terr. Moll. Society Isls., vol. ix, p. 62, pl. 3, fig. 57.
P. arguta Schm., Martn. and Langk.

P. minuta Pfr. P. Z. S., p 384, 1856. *Admiralty Islands.*

P. minuta Pfr., iv, p. 514. Hartm.
P. minuta Pfr. Nom. Helic. Viv., p. 303.

X. *Rosea Group.*

† **P. rosea** Brod. (Bulimus). P. Z. S., p. 125, 1832. *Huaheine.*

P. rosea Müll. Rve., Jay, Pfr., Pse., Päetl., Schm., Hartm., Garr.
P. rosea Pfr. Nom. Helic. Viv., p. 301.
P. purpurascens Pfr., iv, p. 511. Hartm.
P. simplaria Morelet. Jour. Conchyl., iv, p. 370, pl. 11, figs. 13–14, 1853.
P. cognata Pse. Coll. Pse., Schm., Gloyne, Hartm., Garr.

† **P. calypso** O. Semper. Jour. Conchyl., xiii, t. 12, fig. 7. *Island Pelelin.*

P. calypso Pfr., vi, 185; Hartm.; Pfr., Nom. Helic. Viv., p. 300.
P. thetis O. Semp. Jour. Conchyl,, xiii, t. 12, fig. 6.
P. thetis Pfr., vi, 155; Hartm.; Pfr., Nom. Hel. Viv., p. 300.
P. leucothaë O. Semp. Jour. Conchyl., xiii, t. 12, f. 5.
P. leucothaë Pfr., vi, 155; Hartm.; Pfr., Nom. Hel. Viv., p. 300.

Obs.—These shells are all from one island. "The figures are all of one type, differing only in size and coloration."[1]

† **P. varia** Brod. P. Z. S., p. 125, 1832. *Huaheine.*

P. varia Müll. Rve., Pfr., Pse., Päetel, Schm., Hartm., Garr.
Bulimus varius, Pfr.
Bulimus roseus, var., Pfr.
P. varia Pfr. Nom. Hel. Viv., p. 301.
P. glutinoso Pfr. Päetel, Hartm., Garr.
P. mucida Pfr. Hartm., Garr.
P. pulchra Pse., MS. Mus. Godeff. Cat., v, p. 92.
P. Huaheinensis Garr., MS. Hartm., Garr.
P. bicolor Garr., MS. Hartm., Garr.
P. adusta Garr. Hartm., Garr.
P. perplexa Pse. Coll. Pse., Hartm., Garr.

Obs.—Mr. Garrett's residence at Huaheine for some years has

[1] Hartm., in Bib. Cat.

afforded him excellent opportunities of observing this species, and he records very full particulars of its varieties and distribution. I have been in accord with him for a long time in assigning *glutinosa* Pfr. to *varia*. I think Pfeiffer at one time claimed Reeve's fig. 17 *b*, pl. 3, Monog. Part., as his *glutinosa*. This fig. represents the shell in Coll. A. N. S. labeled *P. strigosa* Pse. ex auctore. The latter, however, is a Marquesas shell, which I have recently discovered to = a dark variety of *recta* Pse.

See *recta* Pease.

† **P. assimilis** Pse. A. J. C., p. 230, pl. 15, f. 28, 29, 1867. *Rarotonga Island.*
P. assimilis Pfr., viii, 197 ; Pfr., Nom. Helic. Viv., p. 301 ; Hartm.
P. Cookiana Mouss. MS., p. 28, figs. 28, 29 ; Garr. in litt.
P. Cookiana Mouss. Päetel.

† **P. virgulata** Pse. Jour. Conchyl., 3d series, p. 401, 1876. *Rarotonga.*
P. virgulata Hartm. Bib. Cat. Part., p. 189, 1881.

† **P. subgonocheila** Mousson. Jour. Conchy., xix, t. 3, fig. 4. *Fortuna and Bavao Islands.*
P. subgonocheila Pfr., viii, p. 208, Nom. Helic. Viv., 302 ; Hartm.

XI. *Ganymedes Group.*

† **P. ganymedes** Pfr. (Bulimus). P. Z. S., p. 39, 1850. *Dominique Isld., Marquesas.*
P. ganymedes Rve. Mon. Part., No. 16, pl. 3, fig. 16.
P. ganymedes Pfr. Nom. Helic. Viv., p. 302. Hartm.
P. fasciata Pse. A. J. C., ii, p. 202, 1866, var. Hartm.
P. gonocheila Hartm. (non Pfr.).

† **P. inflata** Rve. (Bulimus). P. Z. S., p. 197, 1842.
P. inflata Rve. Conch. Syst., pl. 175, fig. 11, 12.
P. inflata Rve. Mon. Part., No. 3, figs. 3 *a*, 3 *b*, 1849.
Bulimus thersites Pfr.
Bulimus thersites Chemn., t. 64, figs. 5, 6.
Partulus thersites Albers.
Partula inflata Pfr. Nom. Helic. Viv., p. 303. Hartm.

P. gonocheila Pfr. (Bulimus). Zeit. für Malacol., p. 82, 1847. *Navigator Islands.*
P. gonocheila Pfr., ii, 69.
P. gonocheila Rve. Mon. Part., t. 4, fig. 19.
P. gonocheila Chem., t. 64, figs. 33, 34.
P. ganymedes Hartm. Bib. Cat. Part., p. 182.
P. gonocheila Pfr. Nom. Helic. Viv., p. 302.

Obs.—There seems to be some confusion about this species; the examples of *gonocheila* in the British Museum do not agree

with the figure of *gonocheila* Reeve, which latter = *ganymedes* in my collection. This, however, may be explained by Cuming's habit of substituting what he considered better examples for those already in the Museum collection. Reeve's habitat is Navigator Islands. I have restored the species with the expectation that his *gonocheila* may yet be found at the Navigator Islands. The present examples in the British Museum look to me like some varieties of *recta* Pease.

† **P. recta** Pse. A. J. C., iv, p. 155, pl. 12, f. 8, 1868. *Mountains of Maaui and Nukuhiwa Islds., Marquesas.*

P. recta Pfr., viii, 202. Nom. Helic. Viv., p. 302.
P. strigata Pse. A. J. C., iv, p. 155, pl. 12, f. 7, 1868. *Marquesas.*
P. repanda Hartm. (non Pfr.).

Obs.—This is a very variable shell in size, shape, color and texture. See *recta* Pse., Bib. Cat. Part., p. 186. *P. strigata* Pease = the dark brown variety of *recta*. There were about one-and-a-half pints of examples of this species amongst the duplicates of the collection of the late Wm. H. Pease; four varieties were seemingly embraced in the lot; the larger number were of the white variety, some of which resemble *repanda* Pfr. On a comparison with *repanda* in the British Museum they proved to be distinct. These shells vary from white through different shades of yellow and reddish to dark reddish brown. The inner margin of the aperture is more or less waved and the columella more or less nodose, the lip usually partaking of the color of the shell.

P. repanda Pfr., iv, 512. *New Hebrides.*

P. recta Hartm. (non Pse.).
P. repanda Pfr. Nom. Helic. Viv., p. 302.

† **P. actor** Albers (*Partulus*). Helicien, p. 87, 1850. *Samoa Islds.*

P. actor Pfr., iii, p. 450.
P. actor Chemn., t. 48, figs. 13, 14.
P. actor Pfr. Nom. Helic. Viv., p. 303.
P. Recluziana Petit. Jour. Conchyl., t. 7, f. 5, 1850. *Tutuila.*
P. Recluziana Pfr., iii, p. 452.
P. Recluziana Pfr. Nom. Helic. Viv., p. 303.
P. zebrina Gld. Exped. Shells, t. 6, f. 89. *Tutuila and Samoa.*
P. zebrina Pfr. Nom. Helic. Viv., p. 303.
P. zebrina Hartm. Bib. Cat. Part., p. 189.

Obs.—I have several examples of this shell from the collection of the late Mr. Taylor, England. They were obtained by the

Belcher Expedition (Voyage Samarang). Similar examples are contained in the collections of Gould, Cox and others, from Upolu, Tutuila and Samoa. In Europe *P. expansa* Pse., from Tutuila, is the shell often mistaken for *zebrina*.

† **P. Tryoni** Hartm. P. A. N. S., 1885. *Solomon Islands.*

Buliminoid Division.

XII. *Guamensis Group.*

† **P. Guamensis** Pfr. (*Bulimus*). Phil., Abbild. und Beschreib. Conch., ii, p. 173, pl. 4, f. 9, 1821. *Ponape, Caroline Islands.*

P. Guamensis Pfr., ii, p. 73.
P. Guamensis Rve. Mon. Part., t. 1, f. 4.
P. brumalis Rve. Mon. Part., t. 1, f. 2.
Partula Guamensis Pfr. Nom. Helic., 302. Hartm.

Obs.—*P. Guamensis* Pfr., is not found at Guam, one of the Ladrone Islands, and hence is a misnomer, which might be changed to Ponapensis, one of the Caroline Islands, at which it occurs. The Cox collection contained examples labeled Ascension Island.

P. obesa Pse. A. J. C., iii, p. 223, t. 15, f. 12, 1867. *Fortuna and Vavao Islands.*

P. obesa Pfr., viii, 201.
P. obesa Pfr. Nom. Helic. Viv., p. 302.
P. obesa Hartm. Bib. Cat. Part., p. 184.

Obs.—This species is very scarce as no one has collected in those islands since Dr. Gräff visited them.

P. abbreviata Mousson Jour. Conchyl., xvii, p. 339, pl. 15, f. 7, 1869. *Tutuila.*

P. abbreviata Pfr., viii, p. 200.
P. abbreviata Hartm. Bib. Cat. Part., p. 179 (non *abbreviata* Pse. MS.).

† **P. rufa** Lesson (*Bulimus*). Voy. Coquille, tome 2, pt. 1, p. 324, 1830. *Oualan, Caroline Islands.*

P. rufa Pfr., ii, 229; Nom. Helic. Viv., p. 302.
Partulus rufus Beck.
Partula rufa Less. (non Carpt., Hartm.).

Obs.—This shell, of which Dr. Cox and Capt. Brazier have given me examples, has been re-discovered on the Island of Oualan by Capt. Brazier. It is a much larger shell than *stolida* or *affinis*, with which it is usually confounded.

† **P. conica** Gld. Proc. Bost. S. N. Hist., p. 196, 1841. *Raraka and Samoa Islands.*

P. conica Gld. Exped. Shells, fig. 88.

P. conica Pfr., iii, 445, iv, 507.

P. conica Pfr. Novit. Conch., i, tab. 34, f. 8, 9.

P. conica Pfr. Nom. Helic. Viv., p. 300.

P. Upolensis Mouss. MS. Päetel., p. 104. *Upolu.*

P. canalis Mouss. Jour. Conchyl., xiii, p. 132, 1869. *Upolu, Tulare.*

P. canalis Pfr. Nom. Helic. Viv., p. 300.

P. bulimoides Hartm. Bib. Cat. part, p. 180 (non Less.).

Obs.—I possess these shells from the Islands of Tutuila, Upolu and Samoa. Like *actor* Albers, it is a denizen of several islands of this group. Dr. Gould, in his description of this species, embraces the dextral and sinistral forms of the yellow and brown varieties. Others profess to see a difference, which has resulted in a needless synonymy.

P. bulimoides Lesson. Voy. Coq., p. 326, 1829. *New Guinea.*

P. faba? var., Pfr. Nom. Helic. Viv. p. 302.

P. bulimoides Hartm. Bib. Cat. Part., p. 180.

Obs.—Although Lesson's brief diagnosis of *bulimoides* approximates nearer to some varieties of *conica* than to any known species, his measurements of the shell and the locality induce me to restore the species.

XIII. *Macgillivrayi Group.*

† **P. Macgillivrayi** Pfr. P. Z. S., p. 325, 1856. *New Hebrides.*

P. Macgillivrayi Pfr., iv, 508; Nov. Conch., i, t. 17, f. 14, 15.

P, Macgillivrayi Pfr. Nom. Helic. Viv., p. 301; Hartm., Bib. Cat., Part., 184.

† *P. Turneri* Pfr. P. Z. S., p. 140, 1860 vi, 159; Nom. Helic., Viv., 302. *Erromango Island.*

P. Macgillivarayi Hartm. Bib. Cat. Part., 188.

Obs.—I have a number of examples of this shell, which is somewhat variable. I am indebted to Capt. Brazier for specimens from *Vati*, *Sandwich Island*, *New Hebrides.*

† **P. Caledonica** Pfr. (*Bulimus*). P. Z. S., p. 387, 1861, *Vavua. Tavu, Banks Island, N. Hebrides.*

† *P. Pfeifferi* Crosse. Jour. Conchyl., xix, p. 184, 1871. *Vavua, Tavu.*

P. Pfeifferi Pfr. Nom. Helic. Viv., 301.

† *P. Brazieri* Pse. A. J. C., vii, p. 27, pl. 9, f. 5, 1872. *Tutuila.*

P. Macgillivrayi Pfr., viii, 194; Nom. Helic. Viv., 300.

P. Macgillivrayi Hartm. Bib. Cat. Part., p. 180.

Obs.—Capt. Brazier writes that he only obtained one example

of this shell at Tutuila, which was given to Mr. Pease, and never returned. The example in the Coll. A. N. S., labeled "*P. Brazieri* Pease ex auctore" is of the New Hebrides type and agrees with my example of *Turneri*.

P. turricula Pse. A. J. C., p. 196, 1872. *New Hebrides?*

P. turricula Pfr., viii, 197; Nom. Helic. Viv., 301.
P. turricula Hartm. Bib. Cat. Part., p. 188.

† **P. glaber** Hartm. P. A. N. S., 1885. *Hab.?*

† **P. compressa** Pfr. (*Bulimus*), iii, 447. *Fiji Islands.*

P. compressa Rve. Mon. Part., t. 4, f. 20.
P. compressa Pfr. Nom. Helic. Viv., 301.
P. compressa Hartm. Bib. Cat. Part., 181.

† **P. alabastrina** Pfr. (*Bulimus*). P. Z. S., p. 39, 1856. *Fiji Islands.*

P. alabastrina Pfr., iv, 509; Nom. Helic. Viv., 301.
P. alabastrina Hartm. Bib. Cat. Part., 179.

† **P. radiolata** Pfr. P. Z. S., p. 39, 1846. *Guam Island.*

P. radiolata Pfr., ii, 69; Nom. Helic. Viv., 301. Hartm.
P. radiolata Chemn., t. 64, f. 17, 18.
Partulus radiolatus Albers.

† **P. Layardii** Brazier. *Island of Salisboe.*

Obs.—Unlike other Partulæ this species is devoid of embryonic fovea or spiral striæ. The former are minute longitudinal wrinkles, which are continued over the coarse longitudinal striæ of the surface. The aperture is of a reddish orange color, with a large mammilliform tooth on the pillar lip, and a wide columella above, together with an open umbilicus. The general facies is that of a *Placostylus*, which induced Mr. C. F. Ancey to create the subgenus *Diplomorpha* for the species. Mr. Layard having sent me several of the animals in alcohol, they were referred to Mr. Wm. G. Binney, and, notwithstanding the external differences, "he finds the jaw, lingual dentition and genitalia like other Partulæ."

JULY 14.

MR. GEO. Y. SHOEMAKER in the chair.

Thirteen persons present.

On large Crystals of Stibnite.—Dr. A. E. FOOTE exhibited a specimen of stibnite which was shown by the Commissioners of the Japanese Empire at the World's Exposition, New Orleans, and pronounced by them to be the finest ever found. It is a large fan-like group, twenty-two inches high by nine inches wide. The crystals vary in diameter from one to two inches. The largest is perfectly terminated. The Japanese locality, which has hitherto been incorrectly given, is Iyo. On account of their remarkable brilliancy, extraordinary size, and great number of crystalline planes, it is the most remarkable metallic mineral ever found. The known planes of stibnite are now eighty-five, of which forty, described by E. S. Dana from this locality, are new.

JULY 21.

DR. A. E. FOOTE in the chair.

Seventeen persons present.

A paper entitled "Revision of the Palæocrinoidea, Part III," by Charles Wachsmuth and Frank Springer, was presented for publication.

JULY 28.

MR. THOS. MEEHAN, Vice-President, in the chair.

The death of Gen. U. S. Grant, a member, was announced.

The following was ordered to be printed:—

REVISION OF THE PALÆOCRINOIDEA.

BY CHARLES WACHSMUTH AND FRANK SPRINGER.

PART III.

DISCUSSION OF THE CLASSIFICATION AND RELATIONS OF THE BRACHIATE CRINOIDS, AND CONCLUSION OF THE GENERIC DESCRIPTIONS.

INTRODUCTORY REMARKS.

During the five years that have elapsed since the publication of the first part of this work, great progress has been made in the study of the Crinoids, both recent and fossil, and many new and interesting forms have been discovered and described.

A number of publications have appeared, which must be regarded as among the most important contributions that have ever been made to the literature of the subject. During the course of our studies for the present paper, we have had the benefit of these discussions and researches, in many instances through the personal kindness of our scientific friends. We have been especially favored in this respect by receiving from Dr. P. Herbert Carpenter many of the proof-sheets of plates and text, in advance of publication, of his magnificent work on the Crinoids of the Challenger collections. This has been of the utmost value to us, and we feel that we cannot be too grateful to the distinguished author for his courteous attention.

We may be pardoned for alluding to the satisfaction we have felt at the kind reception our work has met, at the hands of our co-laborers both in this country and in Europe. That our views would encounter criticism, was expected, and indeed desired by us. The criticisms have for the most part been made in a true scientific spirit, with a view to elucidating the truth. They have in many cases been of value to us, and have enabled us to review the questions raised in a new light. As a matter of course errors on our part have been discovered and pointed out.

In the meantime we ourselves have learned a great deal more about Crinoids than we knew at the time we wrote our first part, independently of the discussions and criticisms above referred to. We have now a far more complete collection of the literature

than existed in the United States at that time. Our materials for study in the way of specimens have also been greatly augmented, and for many of the advantages we possess in this respect we are under extraordinary obligations to the naturalists and collectors of the United States and Canada. Many of these gentlemen, with rare liberality, have placed their collections at our disposal, and forwarded to us, at the risk of loss in transit, unique, valuable and original specimens. We desire to express our grateful thanks for favors of this kind to Prof. Whiteaves, Director of the Canada Survey; Prof. Whitfield, of the American Museum, New York; Dr. C. A. White, of the Smithsonian Institution; Prof. Worthen, Director of the Illinois State Survey; Mr. Walter R. Billings, of Ottawa; Mr. S. A. Miller and Prof. Wetherby, of Cincinnati; Mr. I. H. Harris, of Waynesville, O.; Mr. William Gurley, of Danville, Ill.; Mr. R. R. Rowley, of Curryville, Mo.; Mr. James Love, of Burlington, Iowa, and others. We are also under great obligations to our friend, Orestes St. John, who executed the drawings which illustrate this paper. We consider ourselves peculiarly fortunate in enlisting the co-operation, for this purpose, of one who is both a trained and able naturalist and a skilful artist.

As a result of our recent researches, we have naturally been led to entertain new ideas, and in some cases to a modification of views at first entertained.

In the present paper, which appears as Part III of the Revision, we give a description of the genera that have not been considered in Parts I and II, and shall also state the results of our further studies in their bearing upon the genera heretofore discussed.

In the beginning of this work we recognized two great divisions among Crinoids, viz.: Palæocrinoidea and Stomatocrinoidea, for the latter of which we afterwards adopted Carpenter's preferable name Neocrinoidea. We divided the Palæocrinoidea into three great families, based upon as many distinct plans of structure. We did not at first undertake to identify the different subgroups into which these might be divided, except provisionally in some instances, although we recognized the propriety of such subdivision. Prof. Zittel had established twenty-two families of Crinoids, and while his classification has great merit, and is in many essential particulars in accordance with our own views, it

was defective in not recognizing the more comprehensive relations which exist among these animals. His groups failed to express the distinctions in plan of structure, which we have pointed out. While we are satisfied that the necessities of classification require the recognition of a large number of family groups, which we have not hitherto sought to define, we are more than ever convinced that the three great groups which we originally established, are the only really reliable ones, for the reason that they are founded upon well-defined plans of structure.

The Plates of the Abactinal System.

Dr. P. Herb. Carpenter in his Challenger Report, p. 1, describes "the organization of a Crinoid to be broadly divisible into two well-marked portions," to which he applies the general names "ambulacral and antiambulacral." The ambulacral portion is "the visceral mass or disk in which is situated the whole of the digestive tube with both its terminal openings, and it contains the central ends of the radial water-vessels and blood-vessels." The antiambulacral portion "consists of the stem and its appendages, the calyx, and the skeleton of the rays, arms and pinnules." The two portions, he states, correspond on the whole to the actinal and abactinal systems of Echinoderms generally, and were developed, respectively, around the left and right water-tube, or what are generally called the left and right larval antimers. The whole of the calyx and the arm skeleton are formed on the right antimer; the disk and the extensions of the peristome, and the perisomic plates clothing its ventral surface, on the left antimer.

In all recent Crinoids, and so far as known, in all Neocrinoids, the calyx is restricted to the dorsal side of the Crinoid, and all structures along the ventral side form a part of the disk or its extensions. The calyx consists of few plates, as a general rule only of basals and radials. Comparatively few genera have underbasals. Interradials have been described only in *Guettardicrinus*, in a few species of *Apiocrinus*, in *Uintacrinus*, and in the remarkable recent genus *Thaumatocrinus* which exceptionally also has anal plates. None of these plates, however, extend beyond the limits of the dorsal cup.

In the Palæocrinoidea the structure of the calyx is much more complex. Underbasals are represented in nearly one-half of the

known genera, and all have interradials, by means of which frequently a large series of arm plates are incorporated into the calyx, and thereby elevated to the rank of radials. The term "calyx," although applied sometimes in a general way to the whole skeleton exclusively of arms and column, has been of late restricted to the dorsal cup, and all structures upon the ventral surface were called variously vault, dome or disk. It has been the general opinion that all plates located ventrally, in analogy with the Neocrinoidea, either were perisomic, or at least formed a part of the actinal system. This is the view expressed by Carpenter in the Challenger Report, and we must acknowledge it was our own until quite recently. We now hold that a large part of the ventral surface, throughout the Palæocrinoidea, was covered by abactinal plates, and that the calyx extended to the summit pieces, the so-called "apical dome plates." In this sense the term "calyx" will be used by us in this part of the Revision, while the plates beneath the free arms comprise the "dorsal cup." We further use the term "ventral disk" exclusively to denote the upper surface of the visceral mass, in which the mouth is situated, and from which the food grooves radiate outward. The "disk" is clothed by the "perisome," which may be exposed to view or subtegminal, simply membranous or studded with plates; if subtegminal, it is covered by the "vault," which may be rigid or pliable.

The name "*Camarata*" is proposed for all Palæocrinoidea in which the lower arm plates are incorporated into the calyx by interradial plates, and in which all component parts of the test, dorsally and ventrally, are solidly connected by suture.

Under the name "*Articulata*" we include those families in which the plates of the test are united by loose ligaments or muscles, and in which they are somewhat movable.

The name "*Inadunata*" is proposed for all Palæocrinoidea in which the arms are free above the first radials and which have five single interradials, located ventrally.

These groups will be better defined at the proper place.

A. *The Basals and Underbasals.*

The basals are represented in the Palæocrinoidea by one or two rings of plates. The basals proper constitute the first ring beneath the radials; the second or proximal ring contains the underbasals.

There is, however, one exception to this rule, presented by the remarkable genus *Acrocrinus* (Pl. 6, fig. 1), in which the basals and radials are separated by from four to fifteen rings of small pieces, their number varying in species, and increasing in the growing Crinoid.

The plates of the basal ring are laterally connected except in the two genera *Zeacrinus* and *Calpiocrinus.* In the former they are small, trigonal, acuminate pieces, which externally, and also at the inner floor of the calyx, are separated by the radials, which with their truncated lower angle meet the underbasals. In *Calpiocrinus* four of the basals seem to be totally absent externally, and only the posterior one is represented by a small quadrangular piece. The underbasals differ considerably in size, and are frequently covered entirely by the column. In such cases it is often exceedingly difficult to distinguish them from the upper stem joint. Several species have been described with underbasals which do not possess them, and *Heterocrinus* and *Glyptocrinus* were thought to contain species with underbasals and without them.

Considering the importance that has been given to the presence of underbasals in classification, and the difficulty of identifying them in some groups, it is of some importance, that we have discovered a method, by which, in most cases, the presence or absence of underbasals can be ascertained accurately from the column, the position this occupies toward the general symmetry of the calyx; from the outer angles of the stem joints, their position and that of the cirrhi, whether these are radial or interradial, and from the direction of the rays in the axial canal. The following rules prevail:—

1. In species with underbasals, whenever the column is pentangular, its longitudinal angles are directed interradially, the sides and columnar cirrhi radially; on the contrary, in species with basals only, those angles are radiàl, the sides of the column and the cirrhi interradial.

2. When there are underbasals and the column is pentapartite, the five sections of the column are radial, the longitudinal sutures interradial, the radiation along the axial canal radial; but the opposite is the case when basals only exist.

For further particulars we refer to our diagrams on Plate 6, which represent species of widely different groups; and we will

state that, notwithstanding we have made the most scrupulous researches throughout our extensive collections and closely examined the descriptions and figures, we have not found a single exception to this rule among all Palæocrinoidea. There are slight deviations, caused by the quadrangular form of certain columns in species which have otherwise a pentamerous symmetry, but we find this also among the basals, which, when composed of four pieces, cannot be strictly interradial.

Among Neocrinoidea, our investigations could be extended only to comparatively few genera, as unfortunately these forms have either a round column or a circular canal. Only in a few species of *Pentacrinus*, *Millerocrinus* and *Apiocrinus* did we succeed in making out one or the other of these points. In these genera, underbasals are said to be absent, but, curiously enough, the outer angles of the column are interradial, the cirrhi and radiation along the axial canal radial, exactly as in the column of Palæocrinoidea with underbasals, and what is more remarkable, as in *Extracrinus*, in which, on the contrary, underbasals are said to be present. The latter seems to suggest that probably many Neocrinoidea either possess small underbasals, or these were present in their larval form. This view is strengthened by the fact that underbasals have been found lately in the younger stages of many Ophiurids and Asteroids.

From our observations it is proved conclusively that the underbasals are not developed from the upper stem joint, as had been supposed by some writers, but represent an independent element, as shown by the fact that the longitudinal sections in Crinoids with a quinquepartite column, always alternate with the proximal plates in the calyx. It is also now apparent to us that the underbasals are morphologically of greater importance than has been generally supposed.

Carpenter's important discovery that the basals represent the genitals, the first radials the oculars of the Echini, and consequently that the proximal radial ring of plates in dicyclic Crinoids cannot be basals, has been now generally conceded by European naturalists, while in America it has been accepted only by Prof. Wetherby, Prof. Williams and ourselves, although no objections were urged against it until lately by S. A. Miller. The latter, instead of attempting to prove the falsity of Carpenter's views, makes the singular remark that the use of the term underbasals,

in describing species "has given rise to the expression" "underbasals obsolete," "which everyone must concede is ridiculous." Is the phrase "subradials unrepresented" or "obsolete" less ridiculous to Mr. Miller, especially considering that those plates are interradial in position? He further says: "The policy of changing the nomenclature may well be doubted." "The claim is made that the change will bring the nomenclature used in defining recent Crinoids in conformity with that used in describing fossils, but as long as this is doubted, it is better to adhere to the established or prevailing methods of description." We cannot see what this has to do with recent and fossil Crinoids. If it is right in the one group it is right in the other, for they are built fundamentally on the same plan. The question is simply this: In Crinoids with a dicyclic base are the plates of the proximal ring or those of the inner ring the homologues of the basals in monocyclic Crinoids? If the latter is the case, and we think it has been most satisfactorily proved by Carpenter, the term basals should be applied in all cases to the interradial ring, no matter what the "prevailing methods" have been heretofore. Certainly Mr. Miller would not call the anus of fossil Crinoids the mouth, for the reason that it was called so by the most eminent earlier writers. Besides, the term "subradials" is illogical, as the plates to which the name was applied are interradial in position.

In the Neocrinoidea, the basals, with the exception of *Hyocrinus*, consist of five pieces, and in comparatively few cases an anchylosis took place. In the Palæocrinoidea, however, among Crinoids with a monocyclic base, anchylosis of two or more of its plates is the rule. We find five basals only in Silurian genera, but associated with one genus having four. Four basals do not prevail beyond the Devonian, and apparently not beyond the middle portion of it. Three basals commence in the Upper Silurian and continue to the close of the Subcarboniferous, while two basals are found exclusively in the latter epoch.

The number of underbasals is five, with but few exceptions. *Xenocrinus* has four; the *Ichthyocrinidæ*, *Gissocrinus*, *Lecythiocrinus*, *Tribrachiocrinus*, three; while in the Carboniferous *Stemmatocrinus* the underbasals form a perfectly anchylosed disk. The latter was taken by Carpenter to be a top-stem joint, an interpretation which we cannot accept, but as we

discuss this question under *Stemmatocrinus*, we need not enter upon it here. An anchylosis of the underbasals occurs also in *Agassizocrinus* by the deposition of new material around the outer surface before reaching maturity, by means of which the sutures externally and internally become obliterated. The same is the case with the basals in *Edriocrinus*.

In cases of three unequal basals, the position of the smaller plate varies among the different orders, but is unchanged in the same one. In all Palæocrinoidea this plate is located between the anterior and *left* postero-lateral ray (Pl. 6, figs. 21, 25, 26); in the Blastoidea between the anterior and *right* postero-lateral ray (Pl. 6, fig. 24); in the recent genus *Hyocrinus* immediately to the right of the anus (Challenger Report, p. 218). In genera with only two basals, such as *Dichocrinus*, *Talarocrinus*, *Pterotocrinus* and *Acrocrinus*, the interbasal suture passes from the posterior to the anterior side (Pl. 6, fig. 3, and Pl. 9, fig. 1). When there are three unequal underbasals, as in the case of the Ichthyocrinidæ (Pl. 6, fig. 23), and in *Tribrachiocrinus* (Pl. 6, fig. 5), the smaller one is placed anteriorly.

B. *The Radial and Arm Plates.*

With the exception of *Acrocrinus*, the radials proper, the representatives of the oculars, constitute the first row of plates succeeding the basals, with which they alternate. In most of the Palæocrinoidea they do not form a continuous ring, being interrupted posteriorly by an anal piece, and sometimes by additional plates, while in some groups all five radials are separated by five interradials, so as to form jointly a ring of ten plates around the basals. In the Palæocrinoidea generally, the radials and their associates are united by suture with each other and with the basals. In *Cromyocrinus* the union is by syzygy, but in a few of the later Poteriocrinidæ those plates are provided laterally, and toward the basals, with more or less deep fossæ, which suggest a less close union and a certain degree of mobility. In some species of *Forbesiocrinus*, *Ichthyocrinus* and *Taxocrinus*, and probably in the Ichthyocrinidæ generally, the radials were united with one another by muscles; with the interradials, however, by ligament, their lateral faces being provided with deep fossæ and dentations along the edges. (Pl. 5, figs. 3–5).

In some Silurian genera, the radial at the right posterior side

makes an exception to the general rule, by either not touching the basals at all, or only toward the right, as in most of the Poteriocrinidæ and Cyathocrinidæ, while the lower left side abuts against the azygous plate.[1] In still others, one or more of the radials are compound, consisting of two sections, horizontally connected by suture, which, combined, have about the form and size of the adjoining single radials, and are succeeded by the same number of brachials as the others. This peculiar structure, which to some extent disturbs the general symmetry, and which occurs throughout different families, but only among Silurian and Lower Devonian genera, is evidently of some importance as representing a very early phase of these Crinoids. The lower segments are probably embryonal plates, which were resorbed by the upper segments, *i. e.*, the permanent radials; in a similar manner as the azygous and anal plate are resorbed by the right posterior radial, which in most of the earlier Inadunata either is missing, as in the case of *Baerocrinus*, or, as in others, imperfectly developed. In *Baerocrinus*,[2] one of the earliest known Crinoids, the azygous piece forms a continuous ring with its four radials, and has the same proportion. In the allied *Hoplocrinus*, however, the right upper corner of the azygous plate is absorbed and replaced by a small trigonal arm-bearing piece, the right posterior radial; the left corner of the plate remaining intact. This is taken up by the anal piece in *Hybocrinus*. In *Dendrocrinus* the azygous plate is reduced to the size of the posterior radial, with which it is connected by a horizontal suture. In *Homocrinus* this suture assumes a sloping position, thereby again decreasing the proportions of the azygous plate. In *Poteriocrinus* the latter is reduced to quite a narrow piece, and the radial toward the right is almost as large as that on the opposite side. In *Cyathocrinus* and *Graphiocrinus* the azygous plate has disappeared entirely, and both posterior radials are equal in size, but separated by an anal piece. In

[1] The term "azygous plate" is used here, and throughout Part III, exclusively for the unsymmetrical lower plate of the posterior (anal or azygous) interradius, the so-called "first anal plate" of most American writers. We reserve the term "anal piece" for the plate enclosed within the ring of radials.

[2] For further information on *Baerocrinus* and the gradual resorption of the azygous and anal plate in the Inadunata generally, we direct attention to our paper on *Hybocrinus*, *Hoplocrinus* and *Baerocrinus*; *Amer. Journ. Sci.*, 1883, vol. xxvi, p. 365.

Erisocrinus the anal plate also is resorbed, and all five radials are perfectly uniform.

Comparing the gradual reduction of the azygous piece, from a strictly radial non-arm-bearing plate to its ultimate resorption by the right posterior radial, with the modifications which the lower sections of the compound radials undergo among species, it appears to us that the azygous piece may represent the lower segment of the posterior radial. This is further suggested by the genera *Anomalocrinus* and *Heterocrinus*, in which the azygous piece, upon its truncate upper side, supports the right posterior radial, which has the form and position of the upper section of the compound radials; while the azygous piece has the form of their lower section. The respective plates in both cases resemble each other so closely, jointly and separately, that they were all described as radials.

In the Actinocrinidæ, Platycrinidæ, Rhodocrinidæ, and in all groups in which the general symmetry is not disturbed by the presence of an azygous plate, the radials are more or less equal in size, the only remarkable exceptions being the Catillocrinidæ and Calceocrinidæ. In *Catillocrinus* only the two antero-lateral radials are approximately alike. All the others differ widely in shape and size, and while these two plates support from fourteen to thirty arms each, the three others have rarely more than one. Another peculiarity of this genus is that it has no axillary plates, all the arms being given off directly from the radials without the assistance of brachials. *Calceocrinus* has but three radials, of which the anterior one is composed of two parts, which, however, are not always continuous.

Our view, that the arms fundamentally commence with the plate above the first radials, whether this is free or incorporated into the calyx, has been fully accepted by P. H. Carpenter, Chall. Rep., p. 48, who further proves it by the developmental history of the plates. The outer radials, he states, "commence as imperfect rings, which soon become filled up with lengthening fasciculated tissue, just as in the case with the stem joints and later brachials;" but "the first radials, like the basals and orals, commence as expanded cribiform films." He further agrees with us that in practice, for purposes of description, it is more convenient to regard the arms as commencing with the first free plate, provided their real nature is not lost sight of.

The mode of union between the higher radials is either by suture or articulation. A sutural union is found in the Actinocrinidæ, Rhodocrinidæ, Platycrinidæ, Eucalyptocrinidæ, and all genera for which we propose the collective name Camarata. Union by articulation prevails in the radials of the Ichthyocrinidæ, Crotalocrinidæ and the Articulata generally. In most of the Ichthycrinidæ, the transverse faces had muscles and ligament so as to permit motion in all directions (Pl. 6, figs. 3, 4). The lateral faces contain deep fossæ, surrounded by a denticulated margin (Pl. 6, fig. 5). P. H. Carpenter and other writers express the opinion that in *Platycrinus* also the first radials were united to the outer plates by articulation. They evidently were led to this supposition by some of the figures, which show what appears to be a transverse articular ridge, but which really marks out the inner end or termination of the small wedge-shaped second radial. This plate, in many of the Platycrinidæ, does not extend out to the end of the scar, the remaining part being only covered by the third plates. We have examined thousands of detached radials of this genus, which indicate plainly that the union was in most of the species by syzygy, and this explains why the upper radials became so generally detached. Others are joined by a more or less close suture, but none by muscles.

The primary radials of the Camarata consist as a rule of three plates, exceptionally of two or four. *Platycrinus* generally has two, but here the second and third evidently were anchylosed. Many plates show a depression indicating the former suture, which in some of the earlier species is yet visible. The second radial of *Stereocrinus* has the proportions of the combined second and third of the allied *Dolatocrinus*, and the same is true with regard to *Anthemocrinus* and *Eucrinus*. In *Batocrinus* the second radial is short, linear, and found occasionally anchylosed with the third. Four primary radials occur in *Eretmocrinus*, and also in the imperfectly known *Schizocrinus*. From Hall's figure of *Schizocrinus heterodactylus*, N. York Palæont., i, Pl. 26, fig. 5 a, it would appear as if the first and second plate combined were equivalent to the first radial in other genera, and here, as in the case of *Hexacrinus* and *Hoplocrinus*, composed of two parts.

In the Articulata the numbers of their primary radials is more variable, and the presence of four radials by no means the exception; but four are often associated in the same specimen with

three or five. *Taxocrinus Egertoni* Phill. (Geol. Yorksh., Pl. 3, fig. 39), even has seven in one, and six in another ray. *Onychocrinus* very freqnently has five, *Ichthyocrinus* generally three and four in alternate rays, *Taxocrinus* three or four, *Forbesiocrinus robustus* three and two, and *Pycnosaccus* two as a rule. *Forbesiocrinus Agassizi* sometimes has two primary radials in one or more of its rays, most frequently three, but very often four, and all are articulated on a similar plan.

The secondary and higher orders of radials in the Camarata rarely consist of more than two plates, sometimes, however, of one, three or even four. Only *Glyptocrinus*, *Reteocrinus* and allied genera sometimes have a larger number. In the typical Actinocrinidæ, which branch from alternate sides, the higher orders consist as a rule of a single piece to each division of the ray, which always at the one side supports the radial of the succeeding order, at the other a row of brachials. The latter, however, as should be expected from the term, are not free, but connected laterally by suture with their fellows of alternate orders. In the Ichthyocrinidæ, the higher orders of radials agree in number and form, more or less, with the primary ones, and all are similarly articulated.

Free rays are found as a rule in the Platycrinidæ; in *Eucladocrinus* they extend to nearly the full length of the ray, giving off alternately from every second or third plate an arm, and two at the distal end. Similar rays are formed in *Steganocrinus* and in *Melocrinus;* among the Rhodocrinidæ in *Ripidocrinus*.

The arms of the Camarata bifurcate in their free state only in the genera which Zittel included under the name Glyptocrinidæ, in the Rhodocrinidæ, and in a few Actinocrinidæ, but all branch at least once in the calyx. In all young specimens, as well as in the earlier forms, the arms are composed of a single row of plates, which gradually, embryologically and paleontologically, turn into wedge-shaped pieces at the distal end, or even interlock, while in all later genera the arms are composed of alternate joints. In the Upper Silurian, the biserial arm structure predominates and there is not a single species with uniserial arms in the Devonian. Among the free arms there are no syzygies, but every joint in this group bears a pinnule, and these are frequently so closely folded together, that they appear as if suturally connected. In the Articulata, all arms are composed of single joints, which in

their external form agree with the higher radials, being only narrower, and free plates.

In the Inadunata, in which the arms are free from the first radial, the homologues of the outer primary radials, which we have distinguished as brachials, vary in some genera considerably in number. The greatest variation in this regard occurs among the typical Cyathocrinidæ (Cyathocrinites as we called them heretofore), in which the number varies even among the rays of the same species, so much indeed, that one ray may have one, the adjoining two, the next perhaps five or six. The other groups have rarely more than two brachials, and most of them but one. The brachials are regular arm plates, with a well-developed ambulacral furrow, but without pinnules. The arms are composed of single joints, except in the Poteriocrinidæ and Eucrinidæ, in which the biserial arm structure is associated with the uniserial one. Pinnules are wanting in the Hybocrinidæ, Symbathocrinidæ and Cyathocrinidæ, and in the two former the rays are undivided, consisting of a single arm. In the Heterocrinidæ and Belemnocrinidæ, the pinnules are arranged from every second or third joint throughout the entire arm, the non-arm-bearing joints being united by syzygy, while among the Poteriocrinidæ every joint from the second up, bears a pinnule.

C. *The Interradial, Interaxillary and Interbrachial Plates.*

The interradial plates occupy the intermediate spaces between the primary rays; the interaxillaries between the main divisions of the ray; the interbrachials between the arm bases. All these plates may be considered as parts of the same element. The interradials consist primarily of five single plates, which rest either upon the upper or between the lateral margins of two first radials. Only in the genus *Briarocrinus*, and in a few Ichthyocrinidæ, do the interradials commence higher up. Higher orders of interradials are only found in the Camarata and Articulata. Their office is to increase the capacity of the visceral cavity by incorporating the lower arm-plates into the calyx, and also to strengthen it. They are auxiliary pieces, and serve to fill up spaces, and in this capacity adapt their form to adjoining plates. The higher interradials do not possess the morphological importance of the primary ones, which are early developed in the young individual, and represent important elements throughout the

earlier Crinoids. The interradials increase by age, vary greatly in number, often in the same species, and even in different rays. There are generally two plates in the second row, but sometimes one or three; beyond these the arrangement of the interradials is more or less irregular. In the Inadunata the interradials are located exclusively on the ventral side; in the Camarata both dorsally and ventrally.

The Reteocrinidæ and Acrocrinidæ, exceptionally, possess no primary interradials properly speaking. In the former group, all radials, from the basals up, are separated laterally by numerous minute pieces, without definite arrangement. *Acrocrinus* has a large belt of small plates, separating radials and interradials from the basals, and the interradial series proper commences with two plates.

In Part II, p. 15, when describing the structure of the vault of the "Sphæroidocrinidæ," we discriminated between true interradials and interradial dome plates, the former as being developed around the dorsal, the latter around the ventral pole. At that time we were under the impression, and it was the general opinion among naturalists, that the plates of the ventral side in all Crinoids, recent and fossil, constitute a part of the actinal system. It was known to be the case throughout the Neocrinoidea, and among Palæocrinoids we found several genera in which the interradials of the dorsal side are separated from those of the ventral side. In *Batocrinus*, the higher orders of radials frequently are not separated by interradials, as in the case of the primary ones, but join laterally with their fellows, thereby causing an interruption in the interradial series. These cases, however, form exceptions to the rule; the interradials of the two hemispheres almost always meet each other, and there is no dividing line by which they can be distinguished.

That the abactinal interradials extend to the ventral side, is well shown by the Platycrinidæ and Hexacrinidæ, our former subdivisions Platycrinites and Hexacrinites, in which the first interradials occupy the equatorial zone, and all succeeding ones are located ventrally. When we defined these groups, we described the first row of interradials to be composed of a single plate, a statement which is not strictly correct.

Consulting our figures (Pl. 7, figs. 5–8, and Pl. 9, fig. 6), it will be seen that in the Platycrinidæ and Hexacrinidæ, the first row

of interradials contains not one alone, but invariably three or more plates, placed side by side, all resting upon the upper faces of the first radials. Only the middle plate, the one placed upon the outer ends of two radials, corresponds with the first interradial of other groups; the plates at the sides are accessory pieces, and rank as interradials of the second and third row, respectively. Species with a discoid base have sometimes five plates in the same row, of which only the outer ones meet the second radials. In the simplest form of *Platycrinus*, the middle plate connects directly with the proximals, and at the azygous side with anal plates. In most species, however, the first row is succeeded by other interradials, which either connect laterally with their fellows of adjoining sides, forming with them a continuous belt around the peristome (Pl. 5, fig. 9, and Pl. 7, fig. 6), or are separated by radial structures. In either case there is no dividing line between the plates of the outer and inner rows, and the upper rows always rest against the proximals. The case is the same in *Marsupiocrinus* (Pl. 8, fig. 7), *Hexacrinus*, *Dichocrinus* and *Talarocrinus*, and similar in *Coccocrinus* and *Culicocrinus*, which we shall discuss farther on.

In the organization of the Actinocrinidæ, Melocrinidæ, Eucalyptocrinidæ, Rhodocrinidæ, Glyptasteridæ and Reteocrinidæ, the interradials form even more important parts than in the two groups above mentioned. That here the plates of the ventral side form a continuation of the interradials at the dorsal side, is clearly indicated in genera whose arms are given off in clusters, or in which the rays are formed into lateral extensions. In such species, the interradial series are not disturbed by so many radials, nor by interaxillary plates, and the interradials decrease in size gradually all the way from the first interradial up to the proximals. In species, however, in which the arms are arranged in a continuous ring, the interradials decrease in size more or less from the poles toward the periphery. This decrease in the size of the plates toward the equatorial regions is easily explained by the extravagant increase of arms in those species, and by the nature of the interradial plates, which, as stated, are accessory pieces, filling up spaces. An occasional interruption of the series, therefore, is no proof that the two sections represent different elements.

In some genera the interradials of the ventral side are exceed-

ingly small, without definite arrangement, and they cover the surface radially and interradially. This is frequently the case in the Silurian genera, *Glyptocrinus*, *Periechocrinus*, *Melocrinus* and *Beteocrinus*. Their ventral covering resembles so closely the disk of certain Comatulæ, that it might appear as if this multitude of irregular plates, which sometimes decrease in size toward the periphery, and extend out to the free rays, could not be true vault pieces. In proof, however, that this is the case, we refer to Mr. St. John's carefully prepared diagram of *Glyptocrinus ramulosus* Billings, drawn from a specimen in the Canada Survey Museum, and kindly loaned to us by Prof. Whiteaves. Of the specimen only one-half of the calyx is preserved, and this is imbedded in rock, exposing only the inner floor. *Glyptocrinus ramulosus* is the largest species of the genus, and this facilitates the study of the plates. Like all other species of *Glyptocrinus* it has a large number of irregular interradial, interaxillary and interbrachial plates, which meet laterally over the arm openings, and are continued to the summit, leaving no line of demarkation between the plates of the two hemispheres. In the direction of each arm opening the floor is distinctly grooved, and these grooves or depressions, which diverge from the centre to the arm furrows, evidently lodge the ambulacra. That the grooved plates are not covering pieces, is shown by the fact that they have the same irregular arrangement as the other plates. The whole structure reminds us of *Physetocrinus*, and we have no doubt that the vault in those two genera was built essentially on the same plan. We find this further confirmed by the fact, that in the Canada specimen the inner faces of the interradial and interaxillary plates—but not any of the radial ones—are provided with short nodes, such as are found in many Actinocrinidæ, and which serve there as pillars or partition walls between disk and vault.

In the Crotalocrinidæ, which include *Crotalocrinus* and *Enallocrinus*, the whole ventral surface, in what appear to be the best-preserved specimens, is composed of strong, convex plates, without definite arrangement. In these specimens there is no central piece, nor proximals, nor traces of ambulacra (Icon. Crin. Suec., Pl. 7, fig. 3 *a*; Pl. 8, figs. 6, 7, and Pl. 25, fig. 2); there are, however, other figures of Angelin, apparently of a closely allied species (Ibid., Pl. 17, fig. 3 *a*), in which the plates paving the

ventral surface are much more delicate, and consist of a central plate, large proximals, and several rows of covering pieces, without the intervention of either anambulacral or interradial pieces. It would be difficult with the utmost stretch of our imagination to recognize in the former figures either proximals or central piece, which, as admitted by Carpenter, are present in all these Crinoids, and we think there can be little doubt that the two sets of figures represent different parts of the animal, the one the disk, the other the vault, and that the one covered the other. A similar opinion was evidently entertained by Zittel (Handb. d. Palæont., i, p. 357), who stated that *Crotalocrinus* possessed five "grosse Oralplatten, bald unter der Decke, bald äusserlich sichtbar." According to our interpretation, the calyx of the Crotalocrinidæ extends ventrally to the oral pole, and the ambulacra, central piece and proximals are subtegminal, covered by interradial plates, which extend out to the lower rows of covering plates and side-pieces (Icon. Crin. Suec., Pl. 7, fig. 6, and Pl. 25, fig. 15). A similar condition probably prevailed in the Ichthyocrinidæ, with which the Crotalocrinidæ have close affinities.

In the Ichthyocrinidæ, interradials have been observed only at the dorsal side, where they are subject to many irregularities. In some of the genera they are always present, in others entirely absent; while there are still other genera and certain species, in which they are occasionally undeveloped dorsally. The interradials of the Ichthyocrinidæ are united by ligamentous articulation among themselves, and also laterally with the radials, as shown by the presence of deep fossæ at the sides of the plates (Pl. 5, fig. 5). The mobility in the test, resulting from this structure, led us formerly to state that the ventral covering, which is so rarely preserved, "perhaps" consisted of a "soft or scaly integument." The word "soft" was ill-chosen, and did not express our real meaning, we should have said, as we did in other places, "pliable." There is nothing to indicate a membranous surface structure, but the pavement evidently was pliable in conformity with the condition of the test at the dorsal side. In *Onychocrinus exsculptus*, the only Ichthyocrinoid in which portions of the ventral covering have been observed, Lyon and Casseday found in the radial regions rather large, alternately arranged plates (Amer.

Journ. of Sci., 1859, vol. xxix, p. 79), and in another specimen we found, interradially disposed, small imbricating plates connecting with larger pieces. Whether the latter, as we supposed, represent the summit plates, or Lyon and Casseday's alternating pieces, we could not make out satisfactorily. Carpenter took them to be "covering plates of the ambulacra, which perhaps were permanently closed as in the Platycrinidæ, or only temporarily so as in the Neocrinoids; while the small irregular plates, which form the interradial portions of the vault, correspond to the anambulacral plates of recent Crinoids. They pass downward into the interradials at the sides of the calyx, just as in the recent species and in the Liassic *Extracrinus*" (Chall. Rep., p. 181). We accept the first part of this explanation that these alternate plates probably correspond to the covering pieces of the Platycrinidæ; we even admit these plates to be morphologically identical with those along the disk of the Neocrinoidea. But we doubt if the interradial portions in *Onychocrinus*, or *Platycrinus* either, correspond to the anambulacral plates of recent Crinoids. The interradial plates of vault and disk are very distinct structures; the former constitute a part of the abactinal system, while those of the disk are actinal. Before we enter upon further discussion of this subject, we direct attention to the ventral structure of the Blastoidea and Cyathocrinidæ.

The Cyathocrinidæ were described by us as having no interradials, and until lately we considered this a fixed character of this group. The fact that the only plates interradial in position are located ventrally, seemed to us as sufficient evidence that they were actinal plates, and as such they seemed to be the representatives of the oral plates in the Neocrinoidea. We thought the same regarding the deltoids in the Blastoidea, which occupy essentially the same position in relation to adjacent parts as the above plates in the Cyathocrinidæ. Prof. Zittel, in his "Handbuch der Palæontologie, i," like us, called the plates orals in all three groups, and this interpretation was afterwards accepted by Mr. Etheridge, Jr., and P. Herb. Carpenter, in their paper, "On certain points in the Morphology of the Blastoids" (Ann. Mag. Nat. Hist., April, 1882, p. 214), in which these writers state that in Blastoids the calyx is formed "by

the basals, radials or forked pieces, and the deltoid pieces or orals."[1]

The latter statement seems to us an anomaly. It is impossible that those plates can be orals, and at the same time form part of the calyx. The orals in recent Crinoids have never been considered as calyx pieces, and hence, if the deltoids are orals, they do not belong to the calyx. That, however, they are calyx plates is indicated by their position and relations to other parts, and still more by their enormous variation in size among species of the same genus. If the deltoids were orals, the actinal system in the Blastoids, in forms like *Elæacrinus obovatus*, would occupy over three-fourths of the entire test, while in *Heteroschisma*, which has exceedingly small deltoids, these regions would be reduced to a small circum-oral space. The proportions of the actinal and abactinal regions in the test, respectively, were looked upon by Prof. L. Agassiz as determining the different outlines of the various "orders" of Echinoderms, which he ranked according to the greater preponderance of the one over the other, and this, if true, proves conclusively that the deltoids are not actinal plates, and, therefore, are not orals, but must be interradials. The same argument, however, cannot be applied to the Cyathocrinidæ, in which the so-called orals are located ventrally, and from analogy with recent Crinoids should be actinal plates.

By carefully removing the arms in some of our best specimens of *Cyathocrinus*, we succeeded in exposing the ventral surface in several species, and were enabled to observe its structure in various stages of preservation. In a specimen of *Cyathocrinus Gilesi* (Pl. 4, fig. 2), from the Burlington and Keokuk Transition beds, we found *in situ* the five large interradial plates, the so-called orals, all connected laterally, and each one provided along its upper face with a conspicuous central node. In another specimen of the same species (Pl. 4, fig. 3), these interradials were partly covered along their surface by numerous irregular pieces, but so as to leave the central node exposed, the face at a level with the small tegminal pieces. In two specimens of

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[1] We are pleased to state that Dr. P. H. Carpenter, whom we had acquainted with the modification of our views regarding these plates, now fully agrees with us that neither those of the Blastoidea nor Cyathocrinidæ are orals (see Chall. Rep., p. 162).

Cyathocrinus multiradiatus from Crawfordsville, of which the one is figured (Pl. 4, fig. 6), the entire surface of the interradials, and also the circum-oral space, is covered by minute plates, except at one end (see figure) where the plate underneath is exposed to view. The structure is similar in *Cyathocrinus iowensis* from the Lower Burlington limestone (Pl. 5, fig. 7), but there the plates closing the peristome consist of eight considerably larger pieces, placed around a central one, arranged in pairs, of which each pair corresponds in form and position to one of the four large proximals in other genera.

In the above specimens, the so-called orals are covered along their sutures by well-defined ambulacra, lined by side-pieces and covering plates, and these connect laterally with the small tegminal plates which we have described. That all surface plates in these species are perisomic, nobody will doubt after consulting our figures, and that the plates supporting them are interradials and not orals, is proved by the fact that they surround the peristome, but do not cover it, and are succeeded by numerous other plates.

This, however, was not the structure of the Inadunata generally, or even of all Cyathocrinidæ. Angelin figures from the Silurian of Sweden (Icon. Crin. Suec., Pl. 23, figs. 10 *b*, 11), two specimens under the name of *Cyathocrinus alutaceus*, in which the interradials (orals) were exposed, and not covered by plates. They have a central piece, surrounded by four large proximals, and there are, alternating with them, five conspicuous radial dome plates, with numerous irregular pieces along the posterior or anal side, which join the central plate, and extend outwards, forming a short protuberance, composed of small pieces. There are at the surface no traces of ambulacra, and the whole structure ventrally is almost identical with that of certain forms of *Platycrinus*; while the dorsal side of the species shows clearly the characters not only of the Cyathocrinidæ generally, but the detail structure of the genus *Cyathocrinus*. The total absence of ambulacra upon the surface proves that in this species the disk was subtegminal, covered by the plates which have been heretofore called orals, but which are identical with the first interradial plates of *Platycrinus*, and with the first interradials of *Actinocrinus* and other Camarata. The structural identity with all these plates proves that the interradials of the Cyathocrinidæ, and the deltoids of the Blastoidea,

are abactinal plates, that they constitute a part of the calyx; and it proves further, which is equally important, that some of the Palæocrinidæ have abactinal plates along their ventral side. That *C. alutaceus* cannot be retained in the same genus with the Carboniferous forms is self-evident. The two are morphologically in a very different condition, and we should propose for the former a new generic name if we had before us specimens in place of figures.

Carpenter fully accepts the views previously held by us, that in the Camarata all interradials located dorsally are abactinal plates, and those at the ventral side actinal. It should be stated, however, that we had communicated to him, in time for the Challenger Report, the modifications our views had undergone on this point. We make this statement to show that Carpenter's interpretation of the plates was not based upon our—as we believe—erroneous observations, but was the result of his own studies. Carpenter even goes further than we ever did. He asserts that the plates, which we took to be the actinal representatives of the interradials, in some groups, are anambulacral plates, and form a part of the disk.

His interpretations of the interradials in the Platycrinidæ are not always harmonious. If we understand him correctly, he regards the first interradial piece as a calyx plate (Chall. Rep., p. 40), but all succeeding ones as perisomic, "much more substantial, however, than in Neocrinoids, and forming part of the solid covering, but not a true vault or *tegmen calicis*" (Chall. Rep., p. 179). On the same page he states further: "Although believing that the vault of a Platycrinoid corresponds collectively to the orals, interradials, ambulacral and anambulacral plates of Neocrinoids, I do not wish to assert that the Platycrinidæ either had an external mouth or open ambulacra on the disk." On page 178, however, he states that the "series of four or six interradials, corresponds generally to the single large interradial of *Cyathocrinus*." It is not clear to us, how the same pieces can be anambulacral, *i. e.* disk plates, and at the same time "correspond generally" to a true interradial plate. He supports his theory by pointing to the alternating pieces, the so-called "covering plates," which in most of the Platycrinidæ appear along the radial portions of the ventral surface, and which he believes are always subtegminal in *Actinocrinus*. He says: "I do not myself think

that the vault of a Platycrinite was exactly of the same nature as that of an Actinocrinite, *i. e.*, that it covered in the whole of the visceral mass and ambulacra on its upper surface. For if the alternating dome plates represent the covering plates of recent Crinoids, then all the periphery of the dome, outside of the apical dome plates, must be the real ventral surface of the body, and not a *tegmen calicis* as in *Actinocrinus*." And he states further, on page 179: "There is some point on the actinal side of every Crinoid where the food grooves leave the oral system, covering up the peristome in which they originate, and are only closed by the covering plates at their sides." This is quite true as to the Neocrinoidea, in which the calyx is limited to the dorsal side, but not altogether in the case of the older Crinoids, in which the calyx, as we believe, takes up the greater part of the ventral surface, and the covering pieces frequently are embodied among abactinal plates. In the Platycrinidæ the disk is subtegminal, although portions of the covering pieces appear along the surface, but these, in place of lining the sides of the food grooves, are incorporated between the interradials, resting between them as solidly as the summit plates, and cover the food grooves as tightly, as the interradials do in *Actinocrinus*.

Carpenter agrees with us that the radials above the first are fundamentally arm plates, which, in the growing Crinoid, by the increase of interradials, were incorporated into the calyx. During the process of incorporation, by the widening of the equatorial zone, the ambulacral vessels and food grooves of the incorporated arm plates, gradually were lifted out from the arm-furrows, and stretched out along the disk in the form of tubes, being enclosed from above and below by plates. These ambulacral tubes in most of the Actinocrinidæ are altogether subtegminal, and located at a distance from the inner floor of the vault, until on approaching the arm bases they not only come in contact with, but raise up the interradial plates and push them aside, exposing to view the upper rows of tube plates, the so-called covering pieces, which are thence continued along the arm furrows.

In the Platycrinidæ, the conditions are essentially the same as in the Actinocrinidæ, but most generally the covering-plates of the tubes penetrate the vault before they pass into the arms. This takes place either along the outer edges of the proximals,

or beyond the succeeding ring of interradials. In either case, however, the covering-plates join laterally with the interradials, and accommodate themselves, more or less, in form and size, to the surrounding plates, so much, indeed, that frequently they attain the same rigid form as the true vault pieces (Pl. 7, figs. 5, 7, 8). Sometimes, however, as in the case of *Marsupiocrinus cœlatus*, the alternating plates retain their original form and delicate structure, while in the same genus, in *Marsupiocrinus Tennesseæ* (Pl. 8, fig. 7), they are as rigid as the interradials.

For proof that our descriptions of the alternating plates, and the ambulacral tubes generally, are based upon actual observation, we refer to the casts of *Dorycrinus* (?) (Pl. 4, fig. 5), *Strotocrinus* (Pl. 4, fig. 4), and *Platycrinus* (Pl. 5, fig. 9), in all of which the ambulacra, at some distance before entering the peristome, are covered up in the cast and are visible upon the surface only at or near the arm bases. The cast of *Platycrinus*, which we have illustrated, shows beautifully the alternate arrangement of the covering plates, which pass out from beneath a belt of large interradials. Looking at this figure we do not see how Carpenter can any longer maintain that *Platycrinus* possessed no tubular skeleton, and that the upper interradials are anambulacral plates. The specimen will also convince him that there are in this genus upon the surface of the cast no "elevated rounded ridges, almost like strings overlying the surface," as he imagined (Chall. Rep., p. 179), and which, he thought, represented "the open food grooves of recent Crinoids." Among the twelve or more casts of *Platycrinus* which we examined from Mr. Rowley's collection, not one bears that string-like structure, and in all of them the ambulacral tubes are placed around the peristome at a distance from the vault. That even in the Actinocrinidæ those strings which we noticed upon the casts do not represent organs connected with the food grooves, will be shown elsewhere.

Among Actinocrinidæ, and probably in other families, the covering plates sometimes penetrate the interradials in a similar manner as in the Platycrinidæ, and this is so even in the genus *Actinocrinus*. *Actinocrinus stellaris*, from the Mountain limestone of Belgium, has a row of alternating plates covering the food grooves, a character not well shown in De Koninck's figures; although the arrangement of the plates is very regular in the specimens, and almost identical with that of certain species of

Platycrinus. They form a ridge of strong tuberculous plates, and are almost as prominent as the apical or summit plates of this species, while the interradials, from the first to the last, are scarcely convex. The same structure is also found in *Steganocrinus concinnus* (Pl. 8, fig. 4). In *Carpocrinus ornatus*, however, the alternate plates retain, more or less, the character of other perisomic pieces.

Wherever covering plates in the Camarata are exposed, they are invariably placed on a level with the interradials, not upon their surface, and the ambulacra are essentially in the same condition as those of the Actinocrinidæ, only the interradials do not close over them, but are pushed aside. The case, however, is very different in the higher form of *Cyathocrinus*, in which not the covering plates alone, but the whole tubular skeleton and the entire disk is exposed.

The discovery of anambulacral plates upon the surface of the interradials is morphologically of the utmost importance, as throwing light upon the phylogenetic as well as the ontogenetic development of the older Crinoids and their relation to the Neocrinoidea. If a resorption of these interradial plates, as we believe, took place in the Poteriocrinidæ, then the dividing line between the older and later Crinoids becomes so narrow, that it is difficult to decide where the one terminates and the other begins. A resorption of the interradial plates in palæontological times is in accordance with the embryological development of recent Crinoids. Carpenter is inclined to believe (Chall. Rep., p. 40), that the interradial plates, which Sir Wyville Thomson (Philos. Trans., 1865, p. 540) observed in the early larval stages of *Antedon rosacea*, and which he takes to be primary interradials, "eventually undergo resorption like the orals and the anal plate."

In the Neocrinoidea, with the exception of *Thaumatocrinus*, *Guettardicrinus*, and one or two species of *Apiocrinus*, the interradials are represented by indistinct plates, and are only temporarily developed. In the Palæocrinoidea, however, the interradials are permanent, and in some groups so extravagantly developed that they constitute the greater part of the calyx. It is very remarkable that we find the most profuse development of interradials among Silurian genera, which tends to prove that a largely developed interradial system represents a lower grade

of organization in these Crinoids, especially as these plates increase numerically in the individual by growth. In the Crotalocrinidæ they cover the entire peristome, including the central piece and proximals. In the Reteocrinidæ and Glyptocrinidæ they extend from the basals to the central piece. In *Actinocrinus*, *Melocrinus* and *Platycrinus*, from the first radial to the proximals, exactly as in the early *Cyathocrinus*, only that in the latter the interradials consist of a large single plate, in the others of numerous small ones.

If it were true that the deltoids of the Blastoidea, and their representatives, the interradials of the Cyathocrinidæ, were orals, the first interradials of all Camarata would be oral plates, and all higher orders upward growth of the orals. That this is not the case is clearly shown by the fact that all these plates, from the first to the last, are calyx plates, *i. e.*, abactinal; while the orals of the Neocrinoidea are actinal, being developed around the left peritoneal tube.

That the interradials and their associates, the interaxillaries and interbrachials, dorsally and ventrally, are abactinal plates is further shown by the presence of perisomic plates underneath the vault, which, wherever they have been observed subtegminally, extend from the first interradial to the end of the central piece (Pl. 2, fig. 8). The disk of the Palæocrinoidæ, therefore, begins from beneath the first interradial, and rests, as in the Neocrinoidea, against the first primary radial, thereby making the first interradial, in the true sense of the word, a vault plate.[1]

According to Carpenter, the Ichthyocrinidæ and some of the doubtful Silurian forms, such as *Reteocrinus* and *Xenocrinus*,

[1] The term "vault" has been heretofore applied by most writers to all plates of the ventral side. In this sense it is actually a misnomer. If the term is used at all, it should by right include all interradial, interaxillary and interbrachial plates, dorsally and ventrally, and these might be very appropriately designated as vault plates, to distinguish them from the perisomic or disk plates, which are placed beneath the others, and follow their direction. But fearing that the introduction of a new term, or giving a different interpretation to the same term, might produce confusion, we retain it as a convenient and short mode of expression for all plates of the ventral side that are not perisomic. It is therefore a merely conventional term. Carpenter applies it to all actinal plates of the dome, with the exception of the perisomic ones, in which he includes all interradials of the ventral side which he takes to be actinal.

appear to occupy an intermediate position between the heavily vaulted Platycrinidæ and the more thinly plated recent forms.

We have shown already that neither the small irregular plates in *Glyptocrinus*, nor any of the interradials of *Platycrinus*, are perisomic plates, and this in itself is a strong proof, that the structure, which occupies relatively the same position in the allied genus *Reteocrinus*, cannot represent a totally different thing. Carpenter leaves us in doubt whether the so-called disk of *Reteocrinus* and *Xenocrinus* begins at the basals, where those minute irregular pieces commence, or at the equatorial zone, as he believes it does in *Glyptocrinus*. It seems to us, if he had not meant the whole interradial series, he would not have made a comparison of these parts with those of the Liassic *Extracrinus* and recent forms without interradials, but would rather have selected *Thaumatocrinus*, in which interradials are present. He also indicates it by his remarks on the fixed pinnules of *Reteocrinus*, which, as we know, are located dorsally, and which he says (Chall. Rep., pp. 39, 40) are soldered together by the minute irregular plates, which pass insensibly upwards into the plates of the so-called vault, and further: "This condition recurs constantly in the Liassic *Extracrinus*, and in the recent Pentacrinidæ and Comatulæ; and I see no reason to believe that the minute interradials of *Reteocrinus* are in any way different from those of the Neocrinoids. But I regard them as perisomic plates, continuous with those of the disk above, which was in no sense a vault like that of the Actinocrinidæ."

According to this, if we understand him correctly, the calyx in the Reteocrinidæ consisted only of basals, underbasals and radials, which latter throughout their full length were enclosed by perisomic plates. This would be a very peculiar condition for one of the earliest known Crinoids, if we admit that the Palæocrinoids are developed from a lower morphological level than the Neocrinoidea. In support of it Carpenter has no other proof than a superficial resemblance in the form of the plates. There is nothing to show that any of the plates were perforated, there is no external mouth, no food grooves, nor plates that could possibly be considered as covering pieces. All the plates dorsally and ventrally, even those extending to the free rays, have the same irregular arrangement. The ventral surface of *Reteocrinus* is almost identical with that of *Glyptocrinus decadactylus*, which

S. A. Miller (Cincin. Soc. Nat. Hist., Dec., 1883), decribes as follows: "It is composed of numerous polygonal plates. Those in the central part are the larger ones, and each of these bears a central tubercle, which is sometimes prolonged so as to be designated a spine. Toward the margin, or rather following the undulations toward the intertertiary areas, the plates are smaller and possessed of slight convexity. They unite in the depressions in the intertertiary areas with the plates of the calyx, or rather the interprimary radials graduate through the intersecondaries and intertertiaries to the plates of the vault without any line of separation. The plates become smaller as they approach the inner face of the arms, over the swelling undulations of the vault, and continuing to decrease in size, form a somewhat granular, continuous integument, that covers the ambulacral furrows. This continuation of the vault up the inner side of the arms, has been observed for a distance of an inch above the vault, and, no doubt, extended as far as the arm furrow itself."

We have carefully examined Miller's original in Dr. R. M. Byrne's collection, and can attest the correctness of his description. The decrease in the size of the plates toward the periphery, which evidently led Carpenter to consider those plates as an outgrowth from the oral side, is readily explained by the enormous accumulation of plates from the interradial, interaxillary and interbrachial series, which terminate soon after entering the ventral side, or else diminish in width. That the vault in *Glyptocrinus* and *Reteocrinus* extends over the full length of the arms, as suggested by Miller, and that only their large pinnules had open food grooves, is at least doubtful, although it may be possible, as such is the case in the allied genus *Melocrinus*, in which, however, the pinnule-like arms are provided with extra pinnules.

Carpenter attaches considerable importance to our incidental remark, "that the peculiar depressed state of the interradial and interaxillary areas of *Reteocrinus*, the irregularity in the arrangement of their plates, suggests the possibility that those parts were adapted to expansion by the animal." And he makes use of this as an argument in favor of his theory that the ventral plates of *Reteocrinus*, like those of the Ichthyocrinidæ, represent "the plated perisome of the Neocrinoids." That the test of *Reteocrinus* was in any way pliable, has been given up by us entirely, nor do we believe that the pliable test of the Ichthyo-

crinidæ bore any relation to the disk of recent Crinoids, but we believe, as strongly as ever, that their ventral surface was covered by a vault. A vault paved by small irregular pieces, and folded like the disk of recent Crinoids, with elevations following the food grooves, is found not only in *Glyptocrinus* and *Reteocrinus*, but also among the later Actinocrinidæ. The surface elevations, which form natural grooves at the inner floor, represent more or less open galleries, which in other forms are produced by a thickening of the plates along the inner floor. Miller's description of the vault of *Glyptocrinus* would apply equally well to *Physetocrinus reticulatus* which, as we know from actual observation, has a vault and a well-developed disk underneath. An open disk represents a higher form in the developmental history of the Crinoids, than a closed one. This is shown by *Cyathocrinus*, in which the vault is gradually replaced by the disk, and it is very improbable that the Reteocrinidæ, which did not survive the Lower Silurian age, attained a higher organization than most of the Carboniferous Actinocrinidæ.

According to Carpenter (Chall. Rep., p. 172), "the vault of *Actinocrinus* has been developed on the left larval antimer, in exactly the same way as the apical or abactinal system is developed on the right; but the oral system, instead of being limited to five oral plates, as in Neocrinoids, reached a very extensive development, so that in its completest form it represents such a parallel to the apical or abactinal system as is to be met with in no other Crinoid." A similar view was expressed by us when we wrote Part II of this Revision, but we believe the same thing might be said of other Actinocrinidæ and all Platycrinidæ and Rhodocrinidæ.

Carpenter, as we have stated, applies the term "vault" to all actinal plates covering the disk and tentacular vestibule, and in most of the Actinocrinidæ he regards all interradial plates of the ventral side as the representatives of the interradials at the dorsal side. However, in a few Actinocrinidæ and in the Platycrinidæ, Rhodocrinidæ and allied groups, he restricts the vault to the central piece, proximals and radial dome plates if such are present, and all other ventral plates he takes to be perisomic. In the Cyathocrinidæ and Blastoidea he limits the vault to the summit plates; but their interradials, although located ventrally, are said to be abactinal. These interpretations, if correct, woul

suggest, either that the condition of the ventral surface is of comparatively little value for classificatory purposes, or that certain forms, which have heretofore been described under *Actinocrinus*, are structurally very different, and should be referred to remote groups. It would further prove, if the upper interradial plates in *Platycrinus* were anambulacral pieces—because some of the covering pieces are interposed between them—that the higher interradials of *Actinocrinus stellatus*, which are in the same condition, are perisomic, and *vice versa* those of certain Platycrinidæ vault plates; indeed, that the very same plates which in the young Platycrinoid represent vault pieces, are perisomic in the adult.

Carpenter will admit that the minute temporary interradials, which Sir Wyville Thomson observed in the larva of *Antedon*, are the homologues of the large and permanent calyx interradials in the Cyathocrinidæ. In this group, in which the rays are free from the first radial, the interradials, for want of any other lateral support, join with each other, and thereby attain their ventral position; while in the adult Actinocrinidæ and Rhodocrinidæ, which have numerous radial and interradial plates, the first interradials naturally had to be located dorsally. The increase of interradial plates took place gradually in the growing animal, and from that we may reasonably suggest that these Crinoids at one time in their larval state possessed but five single interradials, which met over the disk ventrally, as in the case of *Cyathocrinus alutaceus*. At that time the young *Actinocrinus* was essentially in the condition of a young *Antedon* in which the interradials had made their appearance, however the interradials of the Palæocrinoid were more fully developed. If now *Allagecrinus* and *Haplocrinus*, as suggested by Carpenter, represent palæontologically a very early stage of the larva of *Antedon*, we should like to know something about the condition of the interradial plates in those genera. Are they as yet contrary to all other Palæocrinoidea altogether unrepresented, or here already resorbed by the animal? Both genera have five plates, which occupy the very same position as the interradials of *Cyathocrinus alutaceus*, and *Cyathocrinus Gilesi* (Pl. 4, fig. 2). Why should these be orals, when there is another structure covering the tentacular vestibule, which may represent them, and which, on the other hand, would be totally unrepresented in the *Antedon* larva and in all other Echinoderms?

The phylogenetic evidence indicates clearly that the interradial element takes a most prominent part in the composition of the Palæocrinoidea, and we hope we have proved that these plates were much more extravagantly developed in their earlier types. In Silurian genera they extended over the whole peristome, or the greater part of it. Gradually the summit plates made their appearance, evidently pushed out from beneath, afterwards the covering pieces of the ambulacra, and at last also the anambulacral plates. Even in the Cyathocrinidæ, in which the ventral structure attained a higher form than in any other group, with the exception, perhaps, of the Poteriocrinidæ and Encrinidæ, interradials are not only present, but they occupy the greater portion of the ventral side, and even in those genera in which, perhaps, they were resorbed before the Crinoid reached maturity, they had been previously well developed. Under the weight of this evidence, is it probable that *Haplocrinus* and *Allagecrinus*, which are said to be "permanently in the condition of a very early larva" (Chall. Rep., p. 157), alone among all Palæocrinoidea, should have no interradial plates, and that the plates which occupy their position in these two genera are "oral plates?" We, at least, wish to be excused if we doubt it. Upon palæontological grounds we expect to find in the younger stages of the Palæocrinoid the oral system feebly, the interradial system extravagantly developed, while, according to Carpenter's interpretation of the plates, in the Palæocrinoid larva, the entire ventral surface from the radials up would be oral, *i. e*, actinal.

From an embryological standpoint also, Carpenter's interpretation meets with very serious objections. If *Haplocrinus* represents, as he asserts, a very early stage in Crinoid ontogeny, before the opening of the tentacular vestibule to the exterior, we should like to know how the central piece, the so-called orocentral of Carpenter, made its appearance in the Palæocrinoid. It is not very probable that this plate was present in the early larva, or it would certainly be represented in the larva of the Neocrinoid at the time the oral pyramid was closed. Carpenter claims that it was even unrepresented in *Allagecrinus*, and that the oral pole was closed only by oral plates. This would suggest that it was introduced either by means of a partial resorption of the "oral" pyramid, or by the opening of its plates. The former is exceedingly doubtful, while the latter is clearly not the case in

Haplocrinus nor other Palæocrinoidea, for the proximals which Carpenter takes to be the representatives of the orals, are permanently closed, with the exception of *Coccocrinus*, in which the "orals" are said to be parted, but in which the central plate is wanting.

Another difficulty is offered by the fact that the so-called "oral" plates are pierced by the anal opening, a structure which certainly has no parallel among recent Crinoids.

Allagecrinus was described by Etheridge and Carpenter (Ann. and Mag. Nat. Hist., April, 1881) as without central piece, and the latter has since informed us, that he could not identify any such plate on re-examining the specimens. This, however, does not prove that it was wanting, for we must bear in mind that *Allagecrinus Austinii* is an almost microscopic form, not larger than a coarse grain of sand. The central piece was overlooked by the European naturalists, in the much larger *Haplocrinus*. Goldfuss, however, observed in (*Eugeniacrinites*) *Haplocrinus mespiliformis* (Petref. Germ., i, p. 214) "ein rundes Knöpfchen im Scheitelpunkt," and it is very significant that Etheridge and Carpenter also found in *Allagecrinus* "at the central end of one or more of the plates faint tubercles," for which, according to their own statement, "they can find no explanation." Whether these represent the tubercles which we discovered upon the face of the interradials in *Cyathocrinus multiradiatus* (Pl. 4, fig. 2), we are of course not prepared to assert with certainty, but it is worthy of note that Carpenter regards the latter "as the conical openings in *Granatocrinus Norwordi*,"[1] and it is very possible that they are the same thing in all three groups, which would prove better than anything else, that the plates bearing them are not orals but interradials. The tubercles in *Allagecrinus* (compare Ann. and Mag., ser. 5, vol. 7, Pl. xvi, figs. 3 *b*, 4, 5 and 7 *b*), are evidently of structural value, but as there is but one figured, although the description speaks of one to each plate, and this is located laterally in one specimen and centrally in the other, all interpretations by us must necessarily be more or less problematical. We are inclined, however, to believe that the lateral one (fig. 5), in analogy with *Haplocrinus*, represents the anal opening, *i. e.*

[1] This suggestion was made by Dr. P. Herb. Carpenter in his letter of December 26, after sending him our figures, and he kindly permitted us to make use of it in our writings.

the larger tubercle in *Granatocrinus*, and the central one, if it exists at all, the central piece; but whether this plate is exposed or not, we believe it was represented in the Crinoid, and if it was not inserted between the interradials, it was subtegminal, underneath them.

In the later stages of *Allagecrinus*, according to Carpenter and Etheridge (p. 285), the so-called "orals" are placed "at the centre of the dome, in close contact laterally, so that no opening is visible, but their basal angles are more or less truncated, leaving a superficial gap between every pair of plates, which corresponds in position with the articular facet on the subjacent radial." "The interior of this gap, however, is filled up by the deeper portion of the oral plates." This structure, we admit, indicates that possibly at a more advanced stage of the Crinoid, the plates had separated laterally, similar to the orals in the recent *Holopus*. This, however, which we believe was really the case in *Coccocrinus*, does not prove that the plates of the two groups are homologous, as similar modifications take place among the interradials in the Palæocrinoidea, or as we should say, take place in the earlier Crinoids exclusively in the interradials, while the tentacular vestibule remains perfectly closed. In the case of *Allagecrinus*, the opening out of the plates toward the arm bases, indicates, in our opinion, that the Crinoid is approaching the stage of a Platycrinoid, in which the covering plates part the interradials and enter the vault; previous to the later Cyathocrinoid stage, in which the whole ambulacral skeleton covers the interradials. *Coccocrinus* represents a transition form between the two former, the interradials being separated from one another, forming open clefts with the ambulacra at their bottom.

The ventral side of *Coccocrinus rosaceus* in the best-preserved specimens consists of ten plates, all strictly interradial in position, arranged in five series, which are not in contact laterally nor centrally, leaving five rather conspicuous clefts and a central opening. The outer plate of each series is smaller, the inner resting upon the truncate face of the other. The inner plate at the azygous side is larger, and the anal opening excavated along the suture between the two plates, extending as deeply into the inner as into the outer plate. There are no special anal pieces, neither dorsally nor ventrally.

There is no difference of opinion as to the outer plates, which

all recognize as interradials; the inner ones, however, were designated by Roemer as "kleine interradiale Stücke, welche von dem Mittelpunkte der Scheitelfläche zu den Armen verlaufen." Schultze called them "Scheitelstücke," Zittel and De Loriol "orals," and all speak of open ambulacral furrows leading to the arms, and of an external mouth. The latter two writers refer the genus to the Haplocrinidæ, Schultze to the Platycrinidæ. Carpenter (Chall. Rep., p. 163), regards *Coccocrinus*, "like the recent *Holopus*, to be permanently in the condition of a Crinoid larva in which the orals have not yet moved away from the radials, though separated from one another." In the interpretation of the plates he agrees with Zittel, De Loriol and Allman.

A similar interpretation was given by us in our generic description in Part II, when we took the plates of the inner ring to be identical with the so-called "orals" of *Cyathocrinus*, but this has been abandoned after finding the latter plates to be interradials, and they are now regarded by us as secondary interradial plates. When we adopted Zittel's interpretation, we were misled by the superficial resemblance to the oral pieces in the recent genus *Hyocrinus*, overlooking the fact that the latter rest within a belt of perisomic pieces, in place of interradials in the former. *Coccocrinus bacca*, as seen by Roemer's figure (Fauna West. Tenn., Pl. 4, fig. 5 *c*), has three interradials arranged transversely as in the Platycrinidæ, the outer ones resting against the secondary radials. The presence of higher interradials in this species is sufficient to prove satisfactorily that the genus *Coccocrinus* is no Haplocrinite, and that it does not even go with the Inadunata. It is possible that *Coccocrinus rosaceus* had exceptionally but one interradial within the first row, but as a member of the Camarata it must have possessed higher interradials, like other Palæocrinoids in which the interradials come in contact with the higher radials, contrary to the Inadunata, which have, as a rule, a single interradial plate.

We doubt if even Carpenter, although he is inclined to accept the upper series of interradials in *Platycrinus* as anambulacral plates, will go so far after examining our diagrams, as to include among these the lateral plates of the proximal row, either in *Platycrinus* or *Coccocrinus*, which he overlooked in both genera. *Coccocrinus* is certainly not in the same morphological condition as *Holopus*, even admitting, which we do not, that the upper

interradial plates were orals. In the latter genus, the orals rest against the radials, and the ambulacra are exposed only along the arms. In *Coccocrinus*, however, the so-called "orals" abut with their outer ends against the interradials, and the clefts from the "orals," in place of entering the arms, are continued between the interradial plates.

In Part II, p. 58, we asserted that the clefts along both plates were probably filled in the animal by alternate (covering) pieces, and the summit openings by dome plates; although regarding at that time the inner circlet of interradials as oral pieces. We admit that Carpenter is right in asserting that the existence of covering plates between the orals is contrary to the structure of recent Crinoids, and at variance with the nature of oral plates generally; but considering, as we do now, that the inner as well as the outer plates are interradials, this objection loses its force, since covering plates are found between interradials in most of the Platycrinidæ. Yet the case of *Coccocrinus* is somewhat different from that of an ordinary Platycrinoid, which together with covering pieces has well-developed summit plates, of which no trace has been found in any of the specimens of *Coccocrinus*. Carpenter thinks that in *Coccocrinus* the central piece was unrepresented, that its *five* inner interradials are homologous with the *six* proximals of *Platycrinus*, and that the tentacular vestibule with the mouth at the bottom was exposed to view. This interpretation is a natural consequence of his oral theory, and shows still more forcibly the difficulties of his position. Not only has he to admit a homology of five plates to six, but that in a Silurian genus mouth and food grooves were not covered. This assumption, which represents an enormous advance in the development of the group, not attained by any other Palæocrinoid, is alone sufficient to overthrow his whole theory, and this the more when applied to a genus which decidedly represents a low stage among these Crinoids. What is left to make *Coccocrinus* a Palæocrinoid? Even the asymmetry, which, according to Carpenter, is one of the best characters for separating the older and later Crinoids, is rather problematical, as it has no special anal plate.

Admitting that the inner plates in *Coccocrinus* are secondary interradials and not proximals, we have to account for the absence of these plates in this case. That the summit plates, which

are so universally represented throughout this group, should be totally absent in this genus, seems to us not very probable. Yet the central opening which should contain them is so small, compared with the space taken up by them in *Platycrinus* and allied forms, that it seems almost impossible to have been occupied by seven or more plates. Besides, there is not a single instance known to us, in which either the summit plates or the covering pieces were obliterated in the specimen, leaving at the same time the interradials in position, as we find it in all these specimens. This leads us to the conclusion that in *Coccocrinus*, as in *Platycrinus*, the five interradial series had been separated laterally to their full length, but that the disk covered by the summit plates had not been raised to the surface as in that genus, leaving an open gap and lateral clefts permanently as in *Holopus*, with the exception, however, that in the latter genus the clefts are formed between the orals. According to our interpretation, *Coccocrinus* represents phylogenetically a transition form between *Culicocrinus*, in which the interradials are still closed and its summit plates and covering pieces subtegminal, and *Platycrinus* in which they are incorporated with the calyx. This is the only explanation which meets all difficulties, and brings these genera, with regard to the distribution of the plates, under the same rule with the other Palæocrinoids.

The genus *Symbathocrinus* is morphologically a much higher form than either *Coccocrinus* or *Haplocrinus*, not only because it had better developed arms, but also well developed summit plates. Its summit had never been observed until we removed the arms in very perfect specimens, and succeeded in laying bare the whole ventral surface. It consists of eight plates, four large proximals, which, together with three other plates, along the azygous side, form a closed ring around a very conspicuous central piece, and these again are enclosed by ten or more smaller pieces, which rest upon the highly elevated articular facets of the radials.

These outer plates (there may be one or two additional ones toward the azygous side) are smaller than the proximals; five of them are placed radially, the others interradially. In the first specimen which we dissected, and which was sent to Dr. Carpenter for study, the lateral sutures between the smaller plates could not be distinguished. That plates were interposed between the radials

and proximals (his orals) was clearly shown, and was also noticed by him in his letter. We were, therefore, somewhat surprised when we found them ignored in his discussion, and observed his statement that "the so-called apical dome plates rest directly upon the upper edges of the articular faces." We regret this the more, as we should like to know whether he regards them as calyx or perisomic plates. In our opinion they cannot be perisomic, as five of them have a strictly radial position. Nor do we believe that the five radial openings which we at first thought we observed along the upper angle of these plates, at their juncture with the proximals, are ambulacral or arm openings, as Carpenter suggests. We are inclined to take them for mere depressions along the suture, as it is very improbable that the ambulacra in proceeding to the arms passed over these plates. We regard the five radial pieces as radial dome plates, and the alternate ones as interradials. Carpenter also omits to state whether the "orals" in *Symbathocrinus* consist of five or six pieces. That there are more than five is clearly seen in the specimen which he examined, although the exact number could not be ascertained. Other specimens, however, which we have since prepared (Pl. 4, figs. 9, 10), prove clearly that there are seven pieces. This is morphologically of the utmost importance, as showing that the summit structure of *Symbathocrinus* is altogether different from that of *Haplocrinus* or *Rhizocrinus*, with which Carpenter identifies it, and it is more like that of *Platycrinus*. We shall return to this when we take up the oral plates.

As a result of the foregoing observations, we draw the following conclusions, viz.:—

1. Interradials are represented in all groups of the Palæocrinoidea. They were early developed in the larva, attained at once large proportions, and persisted through life or were resorbed on approaching maturity.

2. They extend invariably to the proximals, or even cover them completely.

3. They are more extravagantly developed in the earlier groups, not always in number, but by extending over comparatively larger space.

4. In all groups in which the arms are free from the first radials, they are represented by only five single plates, and these are located ventrally. Groups with two or more radials have

two at least, and the number increases in proportion to the increase of the radials, by means of which the lower series attain gradually a dorsal position.

D. *The Anal Plates and Anal Tube.*

It has been a general practice to regard all plates of the azygous interradius as anal plates. From a strictly morphological standpoint this is not correct, as comparatively few of these plates are connected with the anal aperture, although all of them are more or less affected by it. Properly speaking, in analogy with recent Crinoids. there is but one true anal plate, and the succeeding pieces are either interradials, or they constitute parts of the anal tube, which, in the growing animal, by the increase of interradials, were incorporated into the test. The latter plates, as representing parts of the calyx, which serve the same purpose as the true anal piece, might be very appropriately distinguished as "higher" anal plates, but unfortunately in many groups it is almost impossible to separate them from the interradials. A discrimination, however, should be made wherever it is practicable.

In the Pentacrinoid larva of *Antedon rosacea*, according to Dr. W. B. Carpenter (Philos. Trans. Royal Soc. London, pp. 726–747), the anal plate makes its appearance almost contemporaneously with the first radials, and stands on a level with them. It is at first a rather irregular plate, which somewhat later takes an elliptic form, and is gradually lifted out from between the radials, and developed into a conspicuous funnel, which disappears at the end of Pentacrinoid life, being removed by resorption.

The earlier stages of the anal plates in the Palæocrinoidea are only known from phylogenetic evidence, but this shows that the modifications which they undergo in palæontological times correspond closely with those of the growing Pentacrinoid. In the Inadunata, which have closer analogies with the Neocrinoidea than the other two groups, and which like them have but a single anal plate, the latter can be traced from its first appearance in the Silurian to its total resorption in the Carboniferous and Trias, and the various conditions of development, as thus represented, form excellent characters for generic distinction. Among the earliest Inadunata, however, we find a transition state which either is unrepresented, or has not been recognized in the Penta-

crinoid. We refer to the development of the anal plate from the so-called azygous piece. That a plate which takes such an important part in the phylogeny of this group should be altogether unrepresented in the young Neocrinoid, seems to us somewhat doubtful, the more so as the Neocrinoidea are in all probability the palæontological successors, if not the linear descendants, of the Inadunata. Possibly the undivided azygous plate, as represented in *Baerocrinus*, has been overlooked in the early larva, and this would not be surprising, as the plate occupies the position, and has very nearly the form of an ordinary first radial.

In our chapter on the radials we have already alluded to the azygous piece, and expressed our conviction that its gradual resorption gave origin, not only to the right posterior radial, but also to the anal plate. We have shown that in *Haplocrinus*, a close ally of *Baerocrinus*, the fifth radial is somewhat rudimentarily represented by a small trigonal piece occupying the right upper corner; that this genus, as yet, had no anal plate, the left corner of the azygous piece being still intact; that in *Hybocrinus* the left side of the plate was taken up by a small anal, and the azygous piece proportionally diminished in size; that in the succeeding stages, which are typified by *Iocrinus*, *Dendrocrinus*, *Homocrinus*, the size of the anal plate gradually increased as the azygous piece diminished; and that at last in *Cyathocrinus* the latter plate was entirely removed, and the anal plate took the position of that in the larva of *Antedon*. These modifications were introduced, as a general rule, in geological succession, but not always uniformly, for in some groups the development went on more rapidly than in others. Such a rapid development took place in *Cyathocrinus*, which existed already in the Silurian, although attaining its maximum representation in the Carboniferous; while in most of the Poteriocrinidæ, which eminently belong to the Carboniferous, the very opposite is observed. The most remarkable deviation in this respect is shown by the symmetrical Silurian genus *Codiacrinus*, which apparently has neither azygous nor anal plate.

The final resorption of both plates is best shown in the Poteriocrinidæ. In *Poteriocrinus*, *Eupachycrinus* and *Zeacrinus*, the azygous plate is comparatively well developed, but completely pushed out of the radial position which it had previously occupied. In these genera the anal plate is small, and the first

plate of the tube forms a part of the calyx. The allied *Graphiocrinus*, however, has no azygous plate, and the posterior basal, which is somewhat elongate, supports upon its truncate upper end only an anal plate. In *Ceriocrinus*, which is in a similar condition, the anal plate is partly lifted out from between the radials, and extends half way beyond the articular faces of these plates. In *Erisocrinus*, the anal plate is not only smaller, but rests wholly upon the radials, beyond the limits of the dorsal cup. Finally in *Encrinus*, this plate seems to have been entirely removed in the adult. We have a specimen of *Encrinus liliiformis* only an inch in length, including the arms, which contains between the arms a row of four conspicuous, slightly convex plates, the upper one triangular, which we regard as plates of an anal tube. This discovery is of some importance, as it tends to prove that *Encrinus* is not a Neocrinoid, but a highly-developed Poteriocrinoid.

In the Silurian *Triacrinus* and *Pisocrinus*, which we arrange under the Symbathocrinidæ, we find dorsally no anal plate, but simply an azygous piece. This supports both posterior radials, which are less than half as large as the two antero-lateral ones, and join laterally. In the Carboniferous genus *Symbathocrinus*, however, the azygous plate is wanting, the radials are almost equally developed, and these support a small anal piece. In the allied *Stortingocrinus* and in *Stylocrinus* (*Symbathocrinus* of Miller and Schultze), although exclusively Devonian genera, we find neither azygous nor anal plate, but *Phimocrinus*, like *Symbathocrinus*, possessed a large anal aperture between the highly extended articular facets of the radials, and may have had an anal plate. Whether the summit plates of the two former genera had reached the advanced state of *Symbathocrinus*, or were yet in the condition of *Haplocrinus*, cannot be ascertained from any of the specimens, but it may well be doubted. In *Haplocrinus* the anal opening is pierced through one of the interradials, and the same may be the case in *Stortingocrinus* and *Pisocrinus*. In *Coccocrinus* and *Culicocrinus*, the anus is located between the first and second radials, piercing the one as much as the other; in *Platycrinus* above the first interradial, being separated from the proximals by a special anal plate.

It has been stated that the Inadunata possess no higher orders of anal pieces, and that the plates succeeding the first, form a

part of the tube. They do not all, however, have the tube well developed, and in some of them it is altogether unrepresented. *Haplocrinus* has a simple anal opening, and herein deviates from most of the other genera of this group. The Hybocrinidæ and *Cyathocrinus alutaceus* have only a short protuberance, composed of small plates.

The simplest tube is found in *Catillocrinus* and *Calceocrinus* (Pl. 5, figs. 15, 16), in which it consists of a single row of very large solid plates, transversely curved like an arm-joint, with a semicircular groove along the ventral side. This groove, which extends from the base of the tube to its distal end, is open in all our specimens. A somewhat similar tube occurs in *Symbathocrinus*, in which the proximal plates at the posterior side are considerably thicker than those upon the other sides.

More important from a morphological standpoint, is the ventral tube of the Heterocrinidæ, Anomalocrinidæ and some Silurian Cyathocrinoid genera in which the anal piece, as in *Catillocrinus*, is succeeded by a row of heavy curved plates, which on the dorsal side pass up to the end of the tube. These plates are bordered laterally by several rows of delicate pieces, pierced by pores or slits along their sides, the whole forming a sac-like appendage. It is very evident that this row of dorsal plates is identical with that of *Catillocrinus* and *Calceocrinus*, and also that the ventral side of the tube in the latter two genera was closed by plates in a similar way.

A still higher form is represented by the later Cyathocrinidæ, which have no such row of dorsal plates, the entire sac being composed of delicate pieces. Most of these are perforated with pores, with the exception of the proximal rows of plates dorsally, which are solid, and also frequently those crowning the distal end; while those facing the ventral side are more or less perforated. Among the earlier Poteriocrinidæ, the sac is large, either cylindrical, club-shaped, conical or balloon-shaped, and it often extends beyond the tips of the arms. In the later Poteriocrinidæ, however, the sac dwindles down to a short cone, even in the asymmetrical *Eupachycrinus*, and it has apparently no pores, at least not dorsally.

In most of the Camarata the anal plate is placed between the first radials, and occupies the lower portion of the dorsal cup. In the Rhodocrinidæ, in which the first interradials alternate with

the first radials, the posterior interradial takes the functions of the anal plate, and the second order of interradials, which consists of two pieces, generally contains the second anal with additional plates above. The anals, as a general rule, are arranged longitudinally, but the row is often interrupted by intervening interradials. In *Reteocrinus*, in which the interradial series consists of small irregular pieces, the posterior side is divided equally by a vertical row of large convex anals, arranged like the plates which constitute the dorsal side in the tube of *Catillocrinus*. The only essential difference between the two structures is that the plates in the latter form a free appendage, similar to that of *Thaumatocrinus*, while those of *Reteocrinus* and *Xenocrinus* are incorporated into the calyx.

All typical Actinocrinidæ, Glyptasteridæ, Barrandeocrinidæ, Acrocrinidæ and Hexacrinidæ have a special anal plate between their first radials, and in most of them the first posterior interradial is split into two halves to receive the second anal plate. However, in *Actinocrinus* and allied genera which we separated under Actinocrinites, the second anal is pushed up to the line of the secondary interradials, although the first interradial, as in the other groups, is divided. The splitting of the first interradial for the reception of an anal piece, to which we have alluded, is of the utmost importance for the study of the summit plates, as we find the same thing there repeated among the proximals.

In the Melocrinidæ the first interradials are undivided, and in most of them the lower anal plate is inserted between the two secondary interradials; in others, however, which have no anals within the dorsal cup, the anals commence at the equatorial zone. In the Platycrinidæ the first interradial of the posterior side is considerably larger, and evidently consolidated with the first anal plate. In the Calyptocrinidæ, finally, the whole calyx, dorsally and ventrally, is strictly symmetrical, the anus central, and the only asymmetry in their structure is found among basals and proximals.

The anal opening in all Camarata is located at the distal end of the tube, whether this terminates within the calyx or is extended into a proboscis, and its position is more or less lateral, except in the Calyptocrinidæ in which it penetrates the central piece. The plates composing the tube of the Camarata are abactinal, and form a part of the posterior interradial series; they

are strong, rigid, without pores, are suturally connected, and their arrangement is irregular. This tube differs essentially from the ventral sac, which forms a part of the disk, and is composed of anambulacral plates, into which the plates of the abactinal tube are incorporated, in a similar manner as the higher radials and proximal pinnules are into the disk of the Neocrinoidea. Moreover, the ventral sac does not contain the anal aperture, which is generally located within the disk. For further consideration of this organ we refer to our chapter on the perisomic plates.

Among the Articulata, the Crotalocrinidæ and Cleiocrinidæ have an anal plate in lateral contact with the radials. The same is the case in the Ichthyocrinidæ, with the exception of *Ichthyocrinus*, which has dorsally no anal plate and generally no interradials. *Pycnosaccus*, *Calpiocrinus*, *Homalocrinus*, *Lecanocrinus*, *Gnorimocrinus* and *Mespilocrinus* have even an azygous piece, which is absent in *Anisocrinus*, *Taxocrinus*, *Onychocrinus*, *Forbesiocrinus* and *Lithocrinus*. An anal appendage has been observed only in *Crotalocrinus* and *Enallocrinus*, located ventrally, close to the periphery. In the former it consists of a tube composed of eight vertical rows of heavy quadrangular pieces, connected by suture. In *Enallocrinus* its form is unknown.

In Part I we described *Taxocrinus*, *Onychocrinus* and *Gnorimocrinus* as having a small lateral tube resting upon the first anal plate. To this Dr. P. H. Carpenter objected in his paper on *Thaumatocrinus* (Philos. Trans. Royal Soc., 1884, pt. iii, p. 928). He admitted "that the arm-like series supported the lower portion of the anal interradius," but doubted "that the plates had been hollowed out on their inner side for the reception of the hind-gut," which "undoubtedly opened to the exterior at a higher level through a regular anal tube, just as in other Crinoids." These objections are well founded, and we are now fully convinced that those plates were bordered laterally by interradial pieces as in *Reteocrinus*.

The Plates of the Actinal System.

A. *The Summit Plates.*

The *summit plates* consist of the actinal plates, overlying and immediately surrounding the peristome. For these plates we have heretofore proposed the name "apical dome plates," but

finding its application somewhat cumbersome, as the word "apical" is used in a different sense, we have abandoned it. The summit plates are represented in the Palæocrinoidea by the *central piece*, the six or more so-called *proximals*, and the *radial dome plates;* in the Neocrinoidea, by the *oral* plates alone.

The orals constitute important elements in the ontogeny of recent Crinoids. They appear at first in the form of a closed pyramid, composed of five triangular plates.

According to Dr. P. H. Carpenter (Chall. Rep., p. 71), "their rudiments appear in the free-swimming larva simultaneously with those of the basals, which are developed spirally round the right peritoneal tube; while the orals appear in a similar spiral around the left one. The skeleton is at first limited entirely to these two rings of plates, the edges of which meet around the equator of the growing cup, though they ultimately become separated by the appearance of the radials between them. At the base of the closed pyramid formed by the oral plates is the upper portion of the larval body, in the centre of which the opening of the mouth is formed. . . . At a certain period of development, the five valves of this oral pyramid gradually separate so as to open the mouth to the exterior, and allow the protrusion of the tentacles, while the floor of the original tentacular vestibule, with the mouth in its centre, becomes the peristome of the growing Crinoid." Afterwards the orals become "completely separated from the basals and radials by the equatorial perisome and are relatively carried inwards, while the second radials project somewhat outwards. . . . The orals are thus left as a circlet of five separate plates protecting the peristome in the centre of the upper surface of the disk." In all Pentacrinidæ and also in the Comatulæ, with the single exception of *Thaumatocrinus*, the orals eventually undergo a process of resorption, while in *Rhizocrinus*, *Hyocrinus*, *Holopus* and *Thaumatocrinus*, they persist through life.

Nothing is known of the orals in Mesozoic Crinoids.

That the orals, which assume such an early prominence in the ontogeny of the later Crinoids, should be unrepresented in palæozoic ones, seems scarcely possible. This has been conceded by various writers, but there is, as yet, much difference of opinion as to the plates which represent them.

The first writer who referred to oral plates in palæozoic

Crinoids was Prof. Allman. He suggested an analogy between the transition stage of *Antedon* and the permanent condition of *Haplocrinus*, *Coccocrinus*, *Stephanocrinus* and *Lageniocrinus*. In these genera he took the plates covering the ventral surface to be the orals. We have already shown that the ventral pyramid in *Haplocrinus* and *Coccocrinus* is composed of interradials and not of orals, and the same may be said of *Stephanocrinus;* while the so-called orals in *Lageniocrinus* are radial in position, and evidently arm pieces.

The next writer on this subject was Prof. Zittel, who thought these plates were present in *Haplocrinus*, *Coccocrinus*, *Symbathocrinus*, in the Cyathocrinidæ, Hybocrinidæ and Crotalocrinidæ. That the so-called orals in the Cyathocrinidæ and Hybocrinidæ are interradials can no longer be doubted; while the orals of Zittel in *Symbathocrinus* prove to be merely articular extensions of the radials, which, in their form, somewhat resemble the orals of recent Crinoids. The so-called orals in the Crotalocrinidæ are identical with the proximals (nobis), and will be discussed in connection with them.

De Loriol substantially accepts Zittel's classification, and also his interpretation of the plates.

Dr. P. H. Carpenter, in the Challenger Report, no longer regards the large interradial plates in the Cyathocrinidæ and Blastoidea as orals, but, as before, he applies the term to the interradials of *Allagecrinus* and *Haplocrinus*, and to the inner ring of interradials in *Coccocrinus*. He also designates as orals the *six* proximals surrounding the central piece, and calls the latter the "orocentral." He further states that orals were "represented in the vault of all Palæocrinoidæ, whether simple or complex, although they are sometimes very greatly reduced." Carpenter's views agree essentially with those of Zittel, only that he extends the term to the proximals in all cases, while Zittel applies it exclusively to those of the Crotalocrinidæ. According to his description, the vault in the Platycrinidæ is paved with well-developed "Centralplatten," and in his general remarks on the Actinocrinidæ he speaks of "seven Scheitelplatten," surrounded by a greater or smaller number of radial and interradial plates.

As for ourselves, we have described orals in *Haplocrinus*, *Coccocrinus*, and in the Cyathocrinidæ; but, as already stated,

later investigations have convinced us that the so-called orals in all three groups are calyx interradials. At no time, however, have we held these plates to be structurally identical with the proximals.

Before attempting to determine the identity and relationship of the oral plates in the older Crinoids, it will be necessary to give a full description of the different plates which constitute their summit.

The central piece, as a rule, is the largest plate of the ventral side. It is not only the centre of figure, but also the centre of radiation, and as such occupies the same position ventrally as the basals occupy on the dorsal side. It is frequently nodose, even spiniferous, but always more or less convex, and has a concavity upon its inner floor, toward which all organs from the arms concentrate. The central piece is surrounded variously by from seven to twelve other plates; four of these are larger than the others, interradial in position, and each one rests upon, and connects with, one of the four regular interradial series. Toward the posterior side there are three smaller plates (Pl. 7, figs. 2, 5, and Pl. 8, figs. 7, 8), rarely two (Pl. 7, figs. 6, 7, 8), which similarly connect with the azygous interradius. The three smaller pieces are frequently separated from the larger ones at each side by a good-sized plate, radial in position (*Xr* in Pl. 7, figs. 3–10, and Pl. 8, figs. 1, 3); sometimes, however, they unite laterally with the larger ones. This is the case in the simpler forms, such as *Symbathocrinus* (Pl. 5, fig. 12), and in *Cyathocrinus alutaceus*. In very complex genera, and especially among the huge forms of the Actinocrinidæ, the four larger plates are also separated by radial structures, generally by three plates longitudinally arranged (Pl. 8, figs. 1, 3, and Pl. 4, fig. 4), of which the inner ones abut against the central piece, the outer ones against the second radial and against the sloping sides of the four large proximals. In species in which the latter are laterally connected, which is much more frequently the case, there is but one radial plate, and this takes the position and functions of the third one. In species with a single radial, this rests at the three anterior rays within the angles formed by the four large proximals; while the plates of the two posterior rays are often laterally inserted between the larger and smaller proximals, abutting against the central piece. These two posterior radials were thought by us, and, we suspect,

also by P. H. Carpenter, to represent a bisected proximal, and the two or three plates which they enclose were supposed to be anals or plates of the anal tube—a mistake easily explained by the fact that the plates stand in line with, and join the four large proximals, and have very near their size. We discovered our mistake when we found that in all internal casts the radiation follows the median line of the plates, and not the suture, as in the case of the proximals. The disturbance in the arrangement of the two posterior radials is evidently due to the anal structures, which pushed these plates out of their regular position. In species with a large subcentral anal tube, the position of these radials is so completely altered that they are sometimes actually placed within the semicircle of the four large proximals. Such is the case in the specimen of *Teleiocrinus* (Pl. 4, fig. 4), in which the anal appendage is almost central. In this specimen, all three anterior rays have three primary radials, while the two posterior ones have four. The inner plates serve as a kind of axillary for the ambulacra of the postero- and antero-lateral rays, which are undivided for some distance, giving off underneath a branch to the outer radials. The presence of a fourth radial is rather an exception, and, indeed, three radials are found, as far as we know, only in the larger species of the Actinocrinidæ. In species in which the covering plates pass out to the surface of the vault, the radial dome plates are frequently either wanting in the three anterior rays, or they are exceedingly rudimentary and very irregular in form, while those of the posterior rays are generally intact (Pl. 7, figs. 3, 9, 10). But in some species the posterior radials are partially or totally resorbed (Pl. 7, fig. 8), and the covering plates pass out directly from beneath the central piece. In *Melocrinus* and *Cyathocrinus alutaceus*, in which the anal structures are comparatively narrow, the central piece being generally surrounded by only six plates, of which two face the posterior side—all five radials are placed outside the ring of proximals; but we have a specimen of *Melocrinus Konincki* in which, exceptionally, the plate of the right postero-lateral ray is placed in line with the proximals. Another interesting departure from the general rule is found among the larger species of *Dorycrinus*, *Megistocrinus* and *Agaricocrinus*, in which the central plate is isolated from the proximals by a belt of small pieces. Not even the proximals are connected with the radial dome

plates, nor with one another, and each summit plate has a totally isolated position. In the smaller species and younger specimens, however, all summit plates are connected, showing that those small inserted plates result from excessive growth, and are introduced to increase the capacity of the visceral cavity.

Higher orders of summit radials exist in comparatively few genera. We must admit that the descriptions which we gave of these plates, although correct as to certain species, cannot be applied to the Palæocrinoidea generally, nor even to all Actinocrinidæ. Many of them have but a single radial, and the plates which we took to be radials in most of them, prove to be interaxillaries and interbrachials, which often attain a larger size than the surrounding plates. A very conspicuous case of this kind is *Dorycrinus*, in which the large spiniferous plate above each ray is not a primary radial as we had supposed, but an interaxillary, for the bifurcation of the ambulacral tube takes place beneath the preceding plate. The misconception of these plates in this and other genera led us to suppose that the arrangement of some of the summit plates was more or less disturbed in all species with a large number of arms, while in fact we had searched for plates which are unrepresented. The arrangement of the summit plates, as a rule, is very regular, and only disturbed by the anal tube. They are readily recognized even in *Megistocrinus*, *Strotocrinus* and *Teleiocrinus* as seen by our diagrams (Pl. 8, figs. 1, 3, 5, and Pl. 4, fig. 4).

It has been stated that the proximals, in all cases in which they have been recognized by us, consist of more than five plates, generally of seven, and we have asserted, which has been accepted by Carpenter (Chall. Rep., p. 167), that the two outer plates at the azygous side are equivalent to, and take the place of a fifth large one, being separated from each other by anal plates or the proboscis. The structure is well shown by our diagrams, but in examining them it must be borne in mind that the plates marked *Xr* are radials, and not interradials as heretofore supposed. The more central the position of the anal aperture, and the larger the size of the tube, the greater is the disturbance in the general arrangement of the summit plates. This might be expected, but it is certainly very remarkable that the azygous proximal is divided also in species in which the position of the anal opening is lateral or dorsal, and totally

outside the ring of proximals. Yet such is the case in *Megistocrinus Evansii* and in *Megistocrinus brevicornis*, in which the anal tube is extremely small, located beneath the arm regions, and separated from the proximals by from ten to twenty rings of plates. At the azygous side they have two well-defined proximals, separated by irregular small plates, in a similar manner as in other groups. If these pieces were orals, as asserted by Carpenter, it is difficult to understand why they should be divided in these species, especially if we take into consideration that the orals in all recent Crinoids, even in the asymmetrical *Thaumatocrinus*, consist of five undivided plates.

There is not a single instance known among recent Crinoids in which the anal opening penetrates the orals, not even in the early larva, in which the oral pyramid occupies the whole ventral surface. In the larva the opening is placed within the equatorial zone, beneath the orals, and the same is probably the case in *Holopus*, in which the orals retain permanently the condition of the larva. In the more advanced stages, the anal opening is carried inward by the gradually increasing perisome, but it remains outside the oral ring in all cases, whether the orals become absorbed as in *Pentacrinus*, *Bathycrinus* and *Antedon*, or are retained permanently as in *Rhizocrinus*, *Thaumatocrinus* and *Hyocrinus*.

In the face of such evidence it seems to us extremely hazardous to assert that in Palæozoic Crinoids the anus penetrated the orals, or was closely connected with them. But we must make this assertion if we are to accept the interradials in *Haplocrinus*, and the so-called proximals in other genera, as the representatives of the orals. We might account for a slight disturbance in the form of the plates in genera in which the anus, or its component parts, come in direct contact with the plates,[1] but in our opinion no explanation whatever can be given why in such forms as *Megistocrinus*, *Crotalocrinus*, etc., the posterior oral plate should be divided. For the same reason we cannot accept the five interradial plates in *Haplocrinus* to be orals. If *Haplocrinus* was in

[1] There is a case in which the anus penetrates the central piece. In the Calyptocrinidæ in which the whole calyx—with the exception of the basals—is symmetrical, the anus is strictly central, and the proximals completely pushed out of position, the central piece is bisected, and the two halves, jointly with the proximals, form the sides of the anal tube.

the condition of the Pentacrinoid larva, as suggested by Carpenter, it should have its anal opening beneath the orals, and not pierced through the upper portion of one of them. The very fact that the anal structures are invariably connected with the proximals, proves to us that the latter are interradials, developed around the left peritoneal tube, in a similar manner as the calyx interradials around the right, and that, as such, they are homologous with the first interradial plate in the calyx, and not with the basals, as suggested by Carpenter. The interradials, and not the basals, enclose the anal plates; there is not a single instance known to us in which an anal plate enters the basal ring. The azygous side of the proximals is generally composed of three adjacent pieces transversely arranged, and a divided interradial, which encloses an anal plate, as in the case of the primary calyx interradials. Sometimes, however, the anal plate is lifted out, and the first row is occupied exclusively by a bisected proximal (Pl. 7, figs. 8–10), as in the apical system of *Actinocrinus*.

It has been observed by Goette (Vergleichende Entwickelungsgeschichte d. *Comatula mediterranea*, Arch. f. Microsk. Anat., 1876, Bd. xii, pp. 621–624), that there exists a complete homology between basals and orals, and that both were developed spirally, the former round the right, the other round the left peritoneal tube. Upon these important observations, with which we fully agree, Carpenter undertakes to build up his proof that the proximals are the orals of the Palæocrinoidea. He reasons as follows (Chall. Rep., pp. 169, 170): "The basals are primitively next to the abactinal centre in Urchins and Stellerids, and are only removed from it in the Crinoid by the growing stem; while the orals are next the actinal centre, no plate being developed there, however, in the recent Crinoid. Did it appear, it would only be in the way, and have to undergo resorption to a greater or less extent, just as the dorsocentral of many Urchins is more or less completely resorbed after the appearance of the anus."

The discovery of a dorsocentral plate in the larva of the Urchins, Starfishes and Ophiurids by Carpenter, Sladen and Lütken, which Carpenter thinks is represented by the terminal plate at the base of the larval stem in Comatula, is to our minds no proof, in the total absence of embryological evidence, that there was a similar plate at the oral side. The so-called "orocentral" is said to be present exclusively in Palæocrinoids, but there it is found in all

of them. It is difficult to believe that a plate so prominent, and so universally represented among the older forms, should be unrepresented in the larva of recent Crinoids before the opening of the oral pyramid. Carpenter's argument, that if the plate was present in the larva it would be in the way, and have to undergo resorption, is certainly not a strong one, for he admits in the Urchins a partial resorption of the dorsocentral after the appearance of the anus, and similar resorptions are going on constantly in the growing Crinoid.

Carpenter's arguments respecting the orals are based essentially upon the existence of an orocentral plate, and if this cannot be proved, his whole oral theory must fall to the ground. In the recent Crinoids, he states: "The embryological evidence clearly indicates that the basals of the abactinal system are represented in the actinal system by the orals. The former are within the ring of radials and next to the dorsocentral; and it seems, therefore, only natural to regard the six proximal interradial plates, surrounding the central piece (orocentral) in the vault of a Palæocrinoid, as representing oral plates."

Admitting that the terminal plate at the base of the larval stem in the Comatulæ represents the dorsocentral of Stellerids and Urchins, a question which we will not discuss, and admitting further, that a similar plate existed dorsally in the young Palæocrinoid, which we have good reason to doubt,[1] we cannot make out the affinities that are said to exist between this plate and the central piece, the so-called "orocentral." The former is the outer end of a mere transitory appendage, which in the growing animal soon withers off, and which is attached to the outer face of the skeleton, forming no part of it. The latter is a permanent plate, which rests within the test and fills a conspicuous place in it. It is the most important plate in the

[1] We have examined a large number of roots, and have in our collection five perfect Crinoids from the tips of the arms to the ends of the rootlets. In all of them the column runs out into numerous branches, which all come to a point, having no special terminal plate. It is evident that the majority of the older Crinoids, either must have lived in a kind of oozy ground, or they led a half-free life in the adult, using the root as an anchor. In the Lower Silurian only we find attached to corals or shells isolated disks, with a pit at the centre, which may represent the terminal plates of *Glyptocrinus*, but nothing like this has ever been found elsewhere.

summit, as it covers the mouth, and lodges underneath the annular vessel, which is the origin and centre of the whole ambulacral system. As such it has not only the position but performs the functions of the closed oral pyramid in the Pentacrinoid larva. Why, therefore, should the proximals be the orals, and the central piece represent something else that is totally unknown in Crinoid ontogeny, and among Echinoderms generally? The proximals, as a rule, surround the peristome, but do not cover it. The tentacular vestibule is closed by the central piece. This is well shown in our specimen of *Batocrinus Christyi* (Pl. 5, fig. 6), in which the perisomic plates extend up to the central piece. Other specimens (Pl. 4, fig. 4, and Pl. 8, figs. 1, 2, 5) show that the radiations pass out from beneath the central piece, and not from beneath the proximals. If there had been such a thing as an "orocentral," it is difficult to understand how this plate could have entered the "oral ring," unless it was developed in the early larva, as the proximals remain permanently closed. The Palæocrinoids, as a rule, have a central piece, but they do not all have proximals, and it is very significant that the proximals are absent in the earliest Silurian genera, and are most conspicuous in the later and higher types. *Heterocrinus juvenis* is evidently in the same morphological condition as *Haplocrinus*. The ring of plates, which Carpenter no longer considers orals in *Cyathocrinus*, encloses a central piece without proximals, and in all probability the same is the case in *Hybocystites* and the Hybocrinidæ generally. The Reteocrinidæ possess only a small central piece, but have no proximals. Are the orals here resorbed, and also the interradials? That would, indeed, suggest a very peculiar condition for a Lower Silurian genus.

The basals, as pointed out by Carpenter, are the most important plates in the calyx. They lodge within their cavity, bounded by the radials, the chambered organ, which is the centre of the nervous and vascular system, and from the basals the axial canals pass out to the radials and arms. In the summit, the central plate occupies, in relation to the radials, the same position as the basals. It is the only summit plate that is represented in every Palæocrinoid, and it lodges underneath the most important organs of the oral system. In view of these facts, and admitting that the orals are the homologues of the basals, there can scarcely

be a doubt that the central piece, undivided as it is, is the true homologue of the oral pyramid as represented in the Pentacrinoid larva.

It is true that the pentamerous nature of the orals is an objection to this interpretation, but we do not believe it a serious one, certainly not so great as is found in attempting to homologize six proximals with five orals.

Of the embryology of the Palæocrinoidea little or nothing is known except from phylogenetic evidence, and even this is limited, and gives information only as to the later stages in the almost fully developed Crinoid. In recent Crinoids, from their earliest stages, the orals are composed of five distinct plates, and it is very possible that the central piece, if representing the orals of the Palæocrinoidea, primitively consisted also of five pieces, which were fused together, and that the suture lines gradually were obliterated by deposition of new material at the outer surface, as in the case of the underbasals in *Agassizocrinus*. Who would have thought that in this genus the thick plate at the dorsal end represented five anchylosed plates, if the sutures had not been fortunately observed in some of the younger specimens? That a similar process probably took place at the outer face of the central piece, is somewhat indicated by the condition of the plate, which is always more or less conical or spiniferous, and wherever the point of the plate has been broken, the missing part is replaced by secretion of new deposit. It seems to us that in a group like the Palæocrinoidea, in which the tentacular vestibule was permanently closed, a gradual anchylosis of the five primary plates is deducible from analogy, and would be in entire accordance with prevailing rules in nature.

Such an anchylosis occurred in palæozoic times among the basals, and this is of considerable importance, as the basals are admitted by Carpenter to represent the orals. In the larva of *Antedon*, the basal ring is formed of five distinct plates, and the same number prevails in the adult throughout the recent Crinoids, if not throughout the Neocrinoidea generally. Among monocyclic Palæocrinoids, however, this number forms the exception, and occurs only in a few Silurian genera. Five are soon succeeded by four, three and two plates. Carpenter finds no objection to call all those plates basals, and to regard them, whether composed of two, three or five plates, as the representatives and homologues

of the orals. Similar modifications occur in the number of underbasals, and among them Carpenter admits three and four plates; but when we find the underbasals in *Stemmatocrinus* evidently fused together to a single piece, he regards this as a stem joint.

Even the joints of the column are sometimes tri- or quinquepartite, from the top of the column to the end of the rootlets, and principally in Lower Silurian genera; nevertheless the stem joints of the Pentacrinoid larva, and those of the Neocrinoidea generally, are undivided throughout. Are we to consider the former as different elements from the latter because they are composed of three or five pieces? Or are we to regard the five plates collectively as the homologues of the undivided joints of recent and other Crinoids? In the latter case, why should not the dorsocentral, *i. e.*, the terminal plate of the column, be divided in one or the other species? That the plate is undivided in the Pentacrinoid larva, and in the few species of *Pentacrinus* in which it has been observed, is by no means a proof that it is so in all Crinoids.

It has been stated by Carpenter that "the basals are within the ring of radials, and next to the dorsocentral." This is no doubt frequently the case, but is not the universal rule. In the Rhodocrinidæ and Reteocrinidæ the interradials are placed between the radials, forming with them a ring of ten plates around the basals, while in the Acrocrinidæ the radials are totally isolated from the basals by a wide belt of plates, which, although not true interradials, may be fairly compared with them (Pl. 8, fig. 1).

At the oral side, the arrangement is fundamentally the same as in the calyx, as can be observed in species in which all summit plates are fully developed. Frequently, however, the first and second radials are orally unrepresented, when the third radials occupy the same position as their representatives in the calyx, which is the same as that occupied by the third summit radials of *Strotocrinus*, etc.

If the orals were represented by the proximals, the latter should be succeeded in all cases by the radials, and not be included in the same ring. There is not a single instance of Crinoids known to us where either a radial or an anal plate entered the basal ring, or where an anal plate entered the

ring of orals, yet all of this must be encountered if we consider the proximals to be the orals. Moreover, in *Strotocrinus* and *Teleiocrinus* the two posterior radials would be placed inside the oral ring, the orals of *Megistocrinus* would enclose a large circlet of interradial pieces; while in *Reteocrinus*, *Glyptocrinus* and other Silurian genera, the orals would be altogether unrepresented. All these difficulties are removed if we regard the central piece as the representative of the oral pyramid, and the proximals as summit interradials. Basals and radials, interradials and anal plates are then found to occupy the same position orally as aborally, and even the small intercalated pieces in the dome of *Megistocrinus* are explained by analogous plates in the calyx of *Acrocrinus*. But on the contrary, if the proximals were the orals, it would follow that the orals were represented in the calyx by the proximal interradials, and not by the basals.

That the proximals, which are such prominent plates in the Palæocrinoidea, are unrepresented in the Neocrinoids, is fully explained by the fact that in the latter the interradials generally were imperfectly developed in the calyx, and hence their absence in that group cannot be considered a serious objection to our views.

We are convinced that neither the underbasals nor the dorsocentral are represented at the summit, especially not the latter. We cannot imagine what office such a plate could possibly have had at the oral side, considering that it constitutes a part of the column, and the Echinoderms at no time, or in any group, were attached at their oral side. That it is represented dorsally in the Stellerids and Urchins is natural, as it represents there in a wider sense the entire column of the Crinoid, but its presence at the oral side would be an anomaly.

It seems to us that a far less objectionable explanation of the central plate than that given by Carpenter, would be to regard it as a posterior oral. In this case the orals would be represented by five plates and not by six; the anus would be placed outside the oral ring, and the radial dome plates would occupy the same position towards the orals as the calyx radials toward the basals. But it would place the mouth underneath the posterior oral, and it offers no explanation of the central piece in *Haplocrinus*.

This view was, perhaps, taken by Zittel in the case of the summit plates of *Crotalocrinus* and *Enallocrinus*, in which the

central plate has a somewhat elongate form, and which he described as having five orals. The summit plates in both genera are subtegminal, being covered completely by interradials, and the same was probably the case in the allied Ichthyocrinidæ, at least in their earlier forms. *Reteocrinus* and *Xenocrinus* were evidently in a similar condition, but it is not known whether they had summit plates beneath the interradials or not. *Glyptocrinus* and most of the Silurian genera of the Camarata had a central piece, but no proximals. In all Devonian Crinoids both plates are generally represented, but they do not attain their full development until the Carboniferous.

It has been asserted by us that the ventral plates in *Allagecrinus*, *Haplocrinus*, *Culicocrinus* and *Coccocrinus*, are calyx interradials and not proximals. In *Allagecrinus* and *Haplocrinus* there are five single plates occupying the same space as the whole series of interradials in other genera. In their simplicity, and in resting upon the radials and closing the peristome, these plates, no doubt, closely resemble the orals in the Pentacrinoid larva, but as calyx interradials they would occupy exactly the same position. There is, however, a very important difference in the structure of the two forms to which no attention has been paid. The orals of the larva and those of *Holopus* rest loosely upon the calyx; while the interradials of *Haplocrinus*, like all other interradials, are united with the radials by a close suture.

It has been proved from palæontological evidence, that in the earlier genera the interradials are more extravagantly developed than in later ones. In *Crotalocrinus* and *Reteocrinus*, the interradials cover the entire ventral surface; in *Glyptocrinus* and *Glyptaster* they extend to the central plate; while in the Carboniferous genera they recede gradually toward the periphery, and the central space is filled by large proximals, and often by radial dome plates. Considering these facts, is it safe to assert that in *Allagecrinus* and *Haplocrinus*, which are regarded as larval forms, interradials are entirely absent, and that all ventral plates are actinal? Is it not more reasonable to imagine that in these low forms the ventral side was covered by the one plate, in a similar manner as in *Crotalocrinus*, *Reteocrinus and Glyptocrinus* by the whole collection of plates? In the Neocrinoidea, from the larva to the adult, all ventral plates are actinal, but in all Palæozoic Crinoids, and we may say in all Palæozoic Pelmatozoa,

the whole, or at least the greater part of the ventral side, is abactinal, and this we consider one of the best distinctions between the two groups. We do not understand how Carpenter can maintain that those plates are orals, and at the same time can retain *Allagecrinus* and *Haplocrinus* under the Palæocrinoidea. He must either refer them to the Neocrinoidea, or accept the so-called "Scheitelplatten" as interradials in their simplest form.

It seems to us that in *Allagecrinus* the interradials cover not only the disk but also the summit plates. *Culicocrinus* is in a similar condition, but has additional interradial plates. In the somewhat higher developed *Coccocrinus*, the interradials are separated from one another, forming lateral clefts and a central gap, evidently to receive the oral plate and the ambulacra, which, however, retain permanently the position which they occupied before the valves separated, and rest in the bottom part of the clefts. In *Haplocrinus* the interradials evidently separated in the growing animal, and the oral plate moved outward, but not sufficiently to bring it to a level with surrounding plates; while the ambulacra remained subtegminal. The interradials, instead of being formed into lateral clefts as in *Coccocrinus*, remained permanently closed by means of lateral growth, as shown by their beveled edges, which are formed into grooves.

From *Haplocrinus* to *Cyathocrinus alutaceus* and *Symbathocrinus* there is but one step. The latter two have proximals, the former not. The proximals, we think, were introduced in the Palæocrinoidea in a similar manner as the perisomic plates in the Neocrinoidea. The interradials by the increasing width of the calyx retreated in the growing Crinoid toward the periphery, thereby forming an open space around the oral plate which was gradually filled by the proximals and other dome plates. *Symbathocrinus* is a much higher form than *Haplocrinus*, as shown by the presence of proximals, by the ventral tube, and by the highly differentiated mode of articulation.

If it were true that the five interradials of *Haplocrinus* and *Allagecrinus* are homologous with the six proximals of *Symbathocrinus*, *Platycrinus* and *Actinocrinus*, and that these plates are orals, it would follow, inasmuch as all later and complex Palæocrinoidea have six plates, that the larger number represented the higher form. And further, that *Haplocrinus* and *Allagecrinus* had reached a degree of development such as attained only by

Neocrinoidea, but existing among them as a constant character through all stages of growth. In the Neocrinoid larva the orals are large, occupying the entire ventral side, or one-half of the entire test, and the conditions are not changed by the introduction of perisome in the adult. In the adult Palæocrinoid the actinal system of plates is restricted to a small space, and it is very improbable that the orals extended out to the radials in the earlier stages, or in such forms as *Haplocrinus* and *Allagecrinus*, which, as admitted by Carpenter, are in the condition of the Palæocrinoid larva.

All this tends to prove that the resemblance between the proximals and the orals in the adult Rhizocrinite or Thaumatocrinite, and the "Scheitelplatten" in *Allagecrinus* and *Haplocrinus* with the Pentacrinoid larva, is altogether superficial, and that the orals, if these are developed in Palæocrinoidea, which we think they are, can only be represented by the central plate.

A resorption of the summit plates may have taken place in the later Inadunata; throughout the Camarata they persisted through life.

B. *The Ventral Perisome.*

The ventral perisome covers the visceral mass or body, and together with the oral plates, forms the surface of the disk. It is composed of the "ambulacral" and "anambulacral" plates. The anambulacral plates are irregular pieces or limestone particles along the interpalmar areas, which consist of the anambulacral plates proper, and the so-called interradial plates of the disk. The former are pierced by numerous water pores, and occupy the spaces between the ambulacra; the latter are not perforated, and occur in the substance of the perisome, uniting the rays and their subdivisions. These interradials must not be confounded with the calyx interradials, which cover those of the disk. The ambulacral plates extend from the peristomial area to the extremities of the arms and pinnules, and consist of the so-called "Saumplättchen" or "covering plates," and the "adambulacral" or "side pieces" which support the former and border the outer margins of the ambulacra.

In the Pentacrinidæ, the perisome is always studded more or less with plates, and these often have a very solid appearance; while in the Comatulæ the entire perisome is sometimes almost, or totally, free from calcareous incrustations.

[illegible] Monocyclica. The perisome [illegible] forming a [illegible] grooves and we [illegible] and the [illegible] former [illegible] [illegible] manner. Each plate of the [illegible] by suture [illegible] In their basal [illegible]

[illegible] The [illegible] however, [illegible] formed by grooves [illegible] closed from below by peri[illegible] toward the arm bases and conti[illegible] The perisome of other genera was prob[illegible]

ably less substantial, and perhaps in some of them altogether membranous. We never observed anything like plates in the Actinocrinites, except in *Physetocrinus*, in which they are well developed. Of this genus we lately obtained a specimen which proved that the small tubercles along the ventral surface, figured by us in Rev. ii, Pl. 19, fig. 5, are not, as we then supposed, openings through the "vault," but impressions of the open spaces between the anambulacral plates. In *Actinocrinus* and allied genera we occasionally find little pillars or nodes along the inner floor, which sometimes suspend fragmentary plates, or portions of a filmy substance, and evidently are parts of the perisome. We found similar pillars along the floor of *Glyptocrinus ramulosus* (Pl. 9, fig. 2) underneath the interradial areas, but not beneath the plates overlying the ambulacra. The latter plates are folded as in *Physetocrinus*, and formed into natural grooves, which evidently harbored the ambulacral tubes.

The ambulacral tubes of the Actinocrinidæ rest upon the perisome, but rarely enter the plates of the vault, and do not become exposed until they enter the free arms. In the Platycrinidæ the structure is essentially the same, but the covering pieces frequently enter the calyx at—or close to—the proximals, and in this case often take the form of vault plates. In the young Crinoid, according to our interpretation, the ambulacral tubes were attached to, and rested primarily within the grooves of the lower arm joints, from which they were gradually lifted out when these became incorporated with the calyx and transformed into radials. It seems to us that, while this was going on, the radial regions of the vault were raised by the ambulacra, thereby producing elevations or folds along the vault of *Glyptocrinus* and *Physetocrinus;* while in *Platycrinus* the ambulacra in many cases penetrated the test.

The tubes are composed of four rows of plates, alternately arranged, of which two constitute the floor, the two others the upper side. The upper ones are the covering pieces, but we are not certain whether those at the floor are side pieces or form a sort of subambulacral plates. The covering plates where they entered the vault were suturally connected, but on entering the arms became movable. Side pieces have never been observed in the Camarata, but covering plates are found occasionally both in arms and pinnules, and were probably present in all of them.

We have noticed (Rev. ii, p. 31) narrow grooves upon the inner surface of the vault, which meet beneath the median part of the oral plate, and follow the subtegminal galleries which enclose the ambulacral tubes. The condition of these grooves can be studied most profitably from natural casts, in which they appear as string-like elevations along the ventral surface. They have been observed most frequently among the Actinocrinites, where they seem to be universally developed, while no traces of them are to be seen in the twenty or more casts of *Platycrinus* which we examined. That they do not represent the ambulacral tubes, is proved by the fact that these are always located at a distance from the inner floor, as beautifully shown in the casts (Pl. 4, fig. 5, and Pl. 5, fig. 9), and wherever we found the tubes intact, they occupy the same position. That the strings are in no way connected with the tubes, is further shown by the fact that they always meet in the centre, while the tubes form a ring around the centre, as also by the irregularity which they exhibit. It is shown by our figures (Pl. 4, fig. 4, and Pl. 8, figs. 1 and 3), that there are always two of them side by side, which at places connect, and again at others depart from one another, with irregular knots at each bifurcation. This structure could not be explained if the strings represented the inner cavity of the ambulacral tubes, as these are very regularly arranged. That the grooves are placed along the solid walls of the test, has led us to suppose that they were axial canals, and that these Crinoids possessed an orocentral nervous system like all other Echinoderms, but contrary to the Neocrinoidea, in which the nervous system, as now generally admitted, is connected with the chambered organ within the basal cavity. Our interpretation becomes more plausible when we consider that in the Camarata the radials are never pierced by canals, and it would be difficult to understand how these ponderous arms could have moved without axial cords, unless their movements were altogether passive. That the canals have been observed only in certain groups, may be explained by supposing that in many cases they probably rested against the wall, without piercing the floor.

That the perisome, wherever found in place, extends all the way from the top of the first interradials to the central piece, is very interesting, and shows a complete resemblance between the ventral perisome of a recent Crinoid, and the body beneath the

vault of an Actinocrinoid. A total resorption of all interradial plates, dorsally and ventrally, and also of the proximals, would reduce an Actinocrinoid, or Platycrinoid, essentially to the condition of a Neocrinoid that has its lower arm joints connected by perisome. The fact that the perisome is continued underneath the proximals, and extends to the central piece, tends to prove that the latter, and not the proximals, represents the oral pyramid, as these plates *surround* the peristomial area but do not cover it (Pl. 1, fig. 6). It further proves that the interradial plates of *Platycrinus*, *Glyptocrinus* and *Reteocrinus* cannot be partly plates of the calyx and partly perisomic, but must be either the one or the other. If the Reteocrinidæ had lived in Carboniferous times, and the Actinocrinidæ in the Lower Silurian, there might be a possibility that in the former the interradials, dorsally and ventrally, as well as the summit plates, had been resorbed; but as they comprise one of the earliest known groups, this interpretation need not be considered, and we can only regard those plates as ill-defined interradials.

We find it difficult to believe that the so-called "interradials" of *Guettardicrinus*, and *Apiocrinus roissyanus* and allied species, are homologous with the calyx interradials of an Actinocrinoid; but regard all those pieces as enormously developed perisomic plates. That they are somewhat heavier pieces and more regularly arranged than those plates usually are, is not sufficient to make them calyx plates, as they evidently adapted their conditions to surrounding parts, and are therefore thick plates from necessity, in order to fill the deep edges of adjoining radials. De Loriol, in the Paléont. Franc. on p. 272, describes them in *Apiocrinus roissyanus* as follows: Pièces interradiales nombreuses, très inégales, elles varient dans chaque espace interradial dans le nombre et l'arrangement. Presque toujours la série commence par une pièce unique, hexagone ou heptagone, qui est la plus grande, quelquefois fort grande. . . . Au-dessus il y a deux, trois, et même quatre pièces plus petites, irregulières, polygonales," etc. This description does not apply to calyx interadials, among which the first plate is always very regular, and the first row never consists of two plates, nor the second variously of two, three or four pieces. This irregularity seems to have puzzled Carpenter, for, on p. 183 of the Challenger Report, he suggests that perhaps the "smaller interradials were perisomic plates."

Why not the first plate also? We seriously doubt if those plates enclose the perisome as the interradials in *Actinocrinus*, or were covered by perisome as in *Cyathocrinus*, and hence believe they are not calyx but perisomic plates, which, like the smaller pieces of *Extracrinus*, united the lower arm divisions. We take the same view of the so-called interradials and interaxillaries of *Uintacrinus*, which merely attained the outer form of calyx pieces, but are true disk plates, and on approaching the ventral side passed into anambulacral pieces instead of harboring or supporting a perisome. The case is altogether different in *Thaumatocrinus*, in which the interradials are placed within the ring of first radials, and as such form, like the anal plate, a primitive part of the calyx. The Crotalocrinidæ present a different perisomatic arrangement from the Actinocrinidæ. The interradials frequently commence in the equatorial zone, and extend over the whole ventral surface, even oral plate and proximals being subtegminal. Their perisome, which was figured by Angelin in *Crotalocrinus rugosus* (Icon. Crin. Suec., Pl. xvii, fig. 3 *a*), is composed exclusively of covering plates. The proximals are long and narrow, and abut with their outer edges against the deflected upper ends of two radials, leaving radially five angular spaces, which are occupied by the ambulacra. These ambulacra, of which the covering plates are visible, bifurcate like those of other groups, but their subdivisions, in place of being separated by anambulacral plates, join each other laterally, and, together with the summit plates, fill the entire ventral surface. The total absence of anambulacral pieces in this genus is a most remarkable feature, but may perhaps be explained by the presence of hydrospires. There are, however, no spiracles nor pores through any of the plates, except along the anal tube, which is perforated along its walls.

The vault of the Crotalocrinidæ extends quite a distance into the free rays, as shown by Müller's and Angelin's figures (Icongr., Pl. 6, figs. 6 and 7, also Pl. 25, figs. 15 and 25, and Akademie der Wissenschaften, 1853, Pl. 13, fig. 10). That those plates are not ambulacral pieces is proved by the fact, that they cover the Saumplatten, and have a different style of ornamentation. Those figures further prove, that the ventral covering was pliable, or the arms could not have assumed that horizontal position, and be folded in other specimens. This is of some importance as dem-

onstrating that a pliable vault may enclose another flexible integument and contain the food grooves underneath, which was seriously questioned by Carpenter (Chall. Rep., p. 182). He evidently overlooked *Crotalocrinus*, for we doubt if he could have taken the small covering plates (Icongr., Pl. 17, fig. 3 *a*) for the representatives of the large rigid plates of figs. 6 and 7 on Pl. 6, or the irregular pieces around the oral pole to be summit plates.

Crotalocrinus and *Enallocrinus* have close affinities with the Ichthyocrinidæ, not only in that both have a flexible skeleton, but they frequently possess no interradials dorsally, and they all have the same peculiar arm structure. In speaking of a pliant vault we do not mean a surface "formed of connective tissue with numerous interradial plates imbedded in it," as supposed by Carpenter (Chall. Rep., p. 182), but a continuous integument of plates connected by ligament in place of suture, sometimes with imbricating plates. We postulated the prevalence of this structure in the vault of the Ichthyocrinidæ from the construction of the dorsal plates, which could not be movable unless the ventral side was pliant also. Our views are confirmed by the vault structure of *Crotalocrinus*, and we think the disk ambulacra of *Ichthyocrinus* were arranged in a similar manner, and covered by a similar vault.

A very different perisome is found in the higher types of the Cyathocrinidæ, which is not subtegminal, but exposed upon the surface of the interradial plates. This form is found only in genera in which the ambulacral tubes rest upon the upper edges of the interradials. It is not restricted alone to the later genera, but occurs in several Silurian forms. Angelin has figured such a disk in *Cyathocrinus lævis* (Iconogr., Pl. 26, figs. 2 and 3), and *Gissocrinus punctuosus* (ibid., Pl. 29, fig. 75 *d*), but we think the structure was not correctly understood. In all cases the five interradial plates are completely covered by small perisomic plates, of which those at the four regular sides are not pierced with water pores, while those toward the ventral sac are generally profusely perforated. In some cases we found the summit plates in process of resorption. In *Cyathocrinus iovensis* (Pl. 5, fig. 7), the larger proximals appear in the form of eight irregular pieces, their edges rounded off; while in *Cyathocrinus multibrachiatus* (Pl. 4, fig. 6) only fragments of the plates are scattered over the perisome.

The disk ambulacra were probably differently constructed from those of the arms (Pl. 4, figs. 6 and 7). The specimens indicate that the plates of the former were suturally connected, while those along the arms were movable. All Cyathocrinidæ, so far as observed, have side-pieces which support Saumplattchen; and these rest upon two series of subambulacral (?) plates, which form the floor of a tube as in the Actinocrinidæ.

The "ventral sac" of the Fistulata was always regarded by us as functionally and structurally distinct from the "anal tube" or "proboscis" of the Camarata. We held the former to be an essential part of the body, and perisomic in its origin; the latter as a mere prolongation of the azygous interradius, and constructed of abactinal plates.

To understand the two structures, we must bear in mind that in the growing Actinocrinoid the capacity of the calyx adequately increased with the growth of the body, and hence was at any time capable of holding the visceral mass. In the Fistulata, however, in which all brachials remain permanently free, and the calyx is not enlarged in proportion to the visceral mass, the posterior side of the disk forced its way out through the anal opening, and formed the so-called ventral sac, which has always a narrow neck along the base. According to our interpretation the *ventral sac is an enormously developed interpalmar area supported by the anal plate*, and as such reminds us of the asymmetrical disk in the recent genus *Actinonometra*, in which the anus is central and the mouth marginal.

In most of the Fistulata, the ventral sac is perforated with round or slit-like openings, transversely arranged, which enter the outer margins of two adjoining pieces, but never penetrate the inner portions of the plates like the water pores of the Neocrinoidea. The openings either extend over the whole surface of the sac; or are arranged in longitudinal rows—porous plates alternating with solid ones;—or the terminal end is composed of large solid pieces, frequently spiniferous; or as in the Carboniferous species of *Cyathocrinus* the entire tube is composed of solid hexagonal plates, and the porous or anambulacral plates are restricted to the small area usually occupied by the smaller proximals. In the Poteriocrinidæ, the anambulacral plates extend over the greater part of the ventral sac, but in the Catillocrinidæ and Calceocrinidæ they are limited to one side of

it. The two latter groups possess a series of large anal plates, arranged horizontally, and these form a proboscis with a furrow at its ventral side. This proboscis was incorporated into the sac in a somewhat similar manner as the lower arm joints and pinnules into the disk of the Neocrinoidea. In this structure the two groups have close analogies with the recent genus *Thaumatocrinus*. In that genus, however, the row of anal plates does not enter the perisome, but forms an independent solid appendage in the shape of a cone, which apparently has no functions, as the anal opening is persomic, and we regard this peculiar appendage as a remarkable instance of atavism.

It is probable that in the latter Poteriocrinidæ and Encrinidæ, the interradials and summit plates became finally resorbed, and the perisome was more or less restricted to the ventral disk, as in these genera the sac dwindled down to a small conical tube, which probably disappeared in *Encrinus* before reaching maturity.

That the openings along the ventral sac are not genital openings, as suggested lately by Trautschold, need not be discussed, as most of the Fistulata have well-developed pinnules, and these are not prehensile organs as supposed by him, but are continuations of the arms which contained the genital glands. Neither is it true that the ventral sac is frequently present or absent in the same species. It existed in every individual, but is rarely preserved in the fossil, and is often obscured by the arms.

Nothing is known from actual observation of the perisome of the Ichthyocrinidæ, and little if anything of the construction of the ventral side in any of their genera. The interradial plates of the dorsal side have been described by us as movable, somewhat irregular in form and arrangement, and upon this, principally, we based our conclusion that the plates of the ventral covering were movable, in some cases perhaps squamous. In *Onychocrinus* only there has been observed by Lyon and us indistinct traces of a ventral covering, but too imperfect to give much information either as to the real nature of the plates, or as to their arrangement. Carpenter regards all interradials of the dorsal side as calyx plates, and all those succeeding them and located ventrally as parts of the disk. We admit that the latter may have a superficial resemblance to the small, irregular and movable perisomic plates of *Extracrinus* and other Neocrinoidea to which he alludes. But we do not understand why a

flexible calyx, with a flexible vault, may not enclose a soft or even a plated disk such as we find in *Crotalocrinus* and *Enallocrinus*. The thinness and irregularity of the plates is no valid argument against it. We find such plates ventrally in *Glyptocrinus* and some species of *Physetocrinus*, and there are plates of the same nature dorsally in the Reteocrinidæ. On the other hand we find massive and more or less regular plates dorsally in *Apiocrinus*, which Carpenter considers to be perisomic. To our minds the case of *Extracrinus* is by no means parallel to that of the Ichthyocrinidæ, as that genus is destitute of calyx interradials. If his argument were correct, then all the plates of the Ichthyocrinidæ and Reteocrinidæ should be considered as perisomic. In that case the perisomic portions of the Crinoid would predominate so enormously that nothing would be left for the abactinal part except the base, and species of *Reteocrinus*, which so good an observer as S. A. Miller considered as congeneric with *Glyptocrinus*, would constitute a distinct order. And we would have the anomaly that the earliest known forms of Crinoids would be in this respect examples of the highest organized types, and most closely allied to the recent Crinoids.

In support of his view, Carpenter has no other proof than this superficial resemblance. There is no evidence of the existence of external food grooves, which must follow if these plates are perisomic. The same reasons that led us to regard the smaller interradials in *Apiocrinus*—massive as they are—as perisomic plates, compel us to consider all plates of the Ichthyocrinidæ, interradial in position, as belonging to the same element, and either all perisomic or all calyx plates.

If the plates in question were perisomic, it would obliterate the last distinguishing feature between Neocrinoids and Palæocrinoids, and we should like to know upon what points Carpenter would separate the Ichthyocrinidæ and Reteocrinidæ from the Neocrinoidæ. We admit that the direct proof of our views as to the ventral structure of the Ichthyocrinidæ is as yet wanting, but in this respect Carpenter is no better off, and it seems to us that the weight of argument from analogy is in our favor.

The Relations of the Palæocrinoidea to the Neocrinoidea.

The name "Palæocrinoidea" was proposed by one of us in 1877 (Amer. Journ. Sci., vol. xiv, p. 190), but not properly defined

until 1879 (Rev. i, p. 30). At that time we also proposed the name "Stomatocrinoidea," and made both groups subdivisions of the "order" Crinoidea, of equal rank with Blastoidea and Cystidea. To the Palæocrinoidea we referred the earlier brachiate Crinoids in which *mouth and food grooves are subtegminal* or hidden from view; to the Stomatocrinidæ the Mesozoic and recent Crinoids in which *mouth and food grooves are exposed upon the disk.* Both groups were admitted by Carpenter and Etheridge, Jr., in 1881, but they changed the name Stomatocrinoidea into "Neocrinoidea" because, as they stated, our name was "long and cumbersome," and they were "by no means sure that some of the Palæocrinoids had not an external anal opening." We might, no doubt, successfully controvert the right of Carpenter and Etheridge to change our name, which had priority, and which was sufficiently defined to be recognized, until they proved satisfactorily that the name-giving characters were inconsistent or incorrect. This view of the case was evidently taken by De Loriol, who in his late work (Paléont. Francaise, tome xi, p. 43) placed both names in equal rank. We hold there is not a single Palæocrinoid known in which either mouth or food grooves are exposed, nor a "Stomatocrinoid" in which they are closed, and this we still regard as one of the best distinctions between the two groups. We, therefore, wish to have it understood that, in accepting Carpenter's name, we do not give up our original position, but yield to the preferable name.

The Crinoidea were subdivided by Joh. Müller into "Crinoidea Articulata" and "Crinoidea Tessellata," the latter including the Inarticulata and Semiarticulata of Miller. Müller's definitions of his groups were extremely vague, but we may conclude from the names and from the genera which he referred to them, that they were based upon a supposed difference in the mode of union of the first radials with the plates which they bear. Among the Tessellata, however, we find *Poteriocrinus* which has highly developed articular facets, not only between radials and brachials, but also at the bifurcations of the arms. Zittel, who adopted Müller's divisions, defined the calyx plates of the Tessellata as "Unbeweglich durch einfache Näthe verbunden;" those of the Articulata as "durch gelenkartig ausgehöhlte und gewölbte oder ebene Nathflächen verbunden." But nevertheless he refers to the Tessellata the Ichthyocrinidæ in which the radials are united with one another by ligament

frequently by muscles also, as seen by the articular faces of *Forbesiocrinus nobilis* (Pl. 5, figs. 3 and 4), and we have seen similar faces in *Ichthyocrinus* and *Taxocrinus*. Among the later Poteriocrinidæ there are also several genera with fossæ along the lateral faces of the radials, which indicate a certain degree of mobility even among the plates of the calyx. On the other hand, the higher radials of the Apiocrinidæ, which Zittel refers to the Articulata, are as solidly united among each other directly, or by means of intercalated plates, as in any so-called "tessellate" Crinoid. All of this tends to prove that a division based upon the mode of union between the plates is totally impracticable, if intended to separate the palæozoic from the later Crinoids, as done by Zittel. We think, however, it affords important data for establishing subdivisions of the Palæocrinoidæ, among which we recognize Articulata and Camarata, the former having their plates connected by articulation, the latter by suture.

The distinctions between the Neocrinoidea and Palæocrinoidea, according to Carpenter (Challenger Report, pp. 149–154), are the following:—

1. In the Neocrinoidea, underbasals are rarely represented; in the Palæocrinoidea, frequently.

2. In the Neocrinoidea "by far the greater number of genera have five equal and similar basals, with five equal and similar radials resting upon them." Exceptions to this rule are found in *Hyocrinus*, which has three basals, and *Holopus* and *Eudesicrinus* in which the radials are not symmetrical; "but this want of symmetry is not due to the intercalation of any anal plate as in nearly all Palæocrinoids."

3. In all Neocrinoidea, with the exception of *Thaumatocrinus*, "the primary radials are in contact with one another by the entire length of their sides; or more rarely, as in *Guettardicrinus*, *Uintacrinus* and *Apiocrinus roissyanus*, their distal angles are cut away so as to receive the lower part of the first interradial. This feature, which is common enough in the Palæocrinoidea, is rare in the Neocrinoidea."

4. Most of the Neocrinoidea have no interradial plates in the calyx, but when present "they are not limited to any special side of the calyx, but are equally distributed all round it, so that there is no distinction of the anal side, *Thaumatocrinus* excepted." In the Palæocrinoidea, however, "the pentamerous symmetry of

the calyx is almost always disturbed by a greater or less modification of the plates on the anal side."

5. In the Neocrinoidea "the basals are pierced by interradial canals or grooves, which lodge the cords proceeding from the angles of the chambered organ," whence they pass into the radials. None of them have permanently imperforate radials as so many Palæocrinoidea, the latter group remaining in an embryonic condition.

6. In the Neocrinoidea, with the exception of *Metacrinus* and *Plicatocrinus*, the axillary is the third of the primary radials; while in the Palæocrinoidea the first radials themselves may be axillary or any other plate beyond the first.

7. The arms of the Neocrinoidea, with the exception of one or two species of *Encrinus*, are uniserial, those of the Palæocrinoidea frequently biserial.

8. The mouth and food grooves of all adult Neocrinoidea are exposed to view; in the Palæocrinoidea, with but few exceptions, closed by plates.

In most of these points we agree with the English scientist, but in some of them we think modifications should be made, and there is one point to which he did not give the importance which we think it deserves.

We agree with Carpenter that underbasals are rarely observed in Neocrinoids, which, as we have stated elsewhere, are built upon the plan of dicyclic Crinoids. The angles of the column are directed interradially, the cirrhi radially; while the opposite is the case in *Actinocrinus*, *Glyptocrinus*, *Belemnocrinus*, *Heterocrinus*, etc., which are known to be monocyclic, and we conclude from this structure that all Neocrinoidea, or at least most of them, in their larval state may have possessed rudimentary underbasals hidden by the column.

Among Neocrinoidea, *Thaumatocrinus* is the only genus in which calyx interradials are evident, and it is very doubtful to us whether even these plates, which rest within the ring of the first radials, really are the homologues of the first interradials of the Actinocrinidæ, Platycrinidæ or Cyathocrinidæ. The interradials of *Thaumatocrinus* were covered in the larva by the oral pyramid; while those of the young Palæocrinoid form the whole of the ventral surface. The so-called "interradials" of *Guettardicrinus*, *Apiocrinus roissyanus*, and *Uintacrinus* we take to be

perisomic plates, and we cannot understand how Carpenter can admit interradials in *Apiocrinus roissyanus*, and not in *Apiocrinus Meriani* (De Loriol, Pal. Franc., tome xi, Pl. 40), *Apiocrinus Rathieri* (Ibid., Pl. 50) and *Apiocrinus murchisonianus* (Ibid., Pl. 53). But it is still more remarkable that in *Apiocrinus roissyanus* Carpenter considers only the first row, and not the succeeding ones also, as calyx plates. The latter are equally solid, suturally connected, and rest like the first plate, between the primary radials.

In our opinion Carpenter lays too much stress upon the asymmetry of the calyx in the Palæocrinoidea, which he attributes to the intercalation of an anal plate. If the asymmetry of the basals was due to that cause only, genera such as *Eucalyptocrinus*, *Coccocrinus*, *Mycocrinus*, *Dolatocrinus* and *Corymbocrinus*, which have no anal plates in the calyx, should have very regular basals, while in fact *Eucalyptocrinus* has the same basal arrangement as *Melocrinus*, *Dolatocrinus* as *Hexacrinus*, *Corymbocrinus* as *Abacocrinus*, the last named of which all possess anal plates. It is also well known that in *Platycrinus* and the Blastoidea, and all other genera with three unequal plates in the basal ring, the smaller plate is always located to one side, not posteriorly, and it is difficult to understand how in *Haplocrinus* the asymmetry of the calyx could be attributed to an anal plate, or to the anal opening, when the latter penetrates the very top of the so-called "orals." We admit that the dorsal cup is more frequently asymmetrical in Palæocrinoidea than in Neocrinoidea, but exceptions are so numerous that we cannot attach to this point the importance that Carpenter does, who considered the symmetry, or want of symmetry, to be the best distinction between the two groups. We believe the condition of the mouth, and that of the oral surface generally, is of much greater importance, and proves to be a more constant character than any of those to which attention has been directed. Carpenter thinks *Coccocrinus* forms an exception to this rule, which he regards to be in the condition of the Neocrinoid genus *Holopus*, and that consequently its mouth was exposed. If this were true, we should not hesitate a moment to refer that genus to the Neocrinoidea, as nothing would be left to make it a Palæocrinoid, not even the asymmetry.

Carpenter denies that interradials are present as a rule in

Palæozic Crinoids, and he, therefore, does not attach to these plates the value which we think they deserve. According to our interpretation they are present in all Palæocrinoids, but absent or incompletely developed in the Neocrinoidea. By means of the interradials the two groups differ essentially in their larval state; the whole ventral surface of the Neocrinoid larva is covered by the orals, but in the Palæocrinoid larva the interradials physiologically take their place, and the orals or their equivalent is subtegminal. The indistinct calyx interradials, which appear for a short period in the Pentacrinoid larva, became resorbed before taking any prominent part in the formation of the calyx, while the interradials of all Palæocrinoids are well defined and permanent plates. It is possible that the interradials of the Encrinidæ were similarly resorbed shortly before the Crinoid reached maturity, but they were evidently well developed in their earlier life, as we may judge from their affinities with the Cyathocrinidæ and Poteriocrinidæ, and this, principally, has induced us to refer them to the Palæocrinoidea.

We propose the following definitions of the two groups:—

PALÆOCRINOIDEA Wachsmuth.

Crinoids with irregularly pentamerous calyx; plates united by suture or articulation. Base monocyclic or dicyclic. Basals and underbasals variable in number. First radials rarely in lateral contact all around, two of them often separated by an anal plate, and sometimes all of them by interradials. The succeeding plates of the rays are free or become incorporated into the calyx. Arms more frequently biserial than uniserial. There is always at least one interradial to each side which is located ventrally, but when there are a number of them, dorsally and ventrally. The interradials extend to the summit plates or cover them, occupy the greater portion of the ventral surface, and either form a vault over the perisome or support the perisome; in either case, however, mouth and disk ambulacra are completely closed. The summit plates are substantially a repetition of the plates in the calyx. They consist of an undivided plate which represents the basals; of the proximals or interradials and anals; and frequently of radial dome plates.

NEOCRINOIDEA Carpenter.

Crinoids with regularly pentamerous calyx, without interradial or anal plates (*Thaumatocrinus* excepted). Underbasals rarely

well developed, being either rudimentary or absent. Basals five, exceptionally three. Radials perforated, and generally united to succeeding plates by a muscular articulation. Rays simple or dividing; the lower arm joints frequently connected laterally by perisome. The first axillary plate generally the second joint after the first radial; arms uniserial. Ventral surface completely occupied by actinal structures, either simply membranous or paved with irregular plates; traversed by the ambulacra, which have open food grooves. Orals five; always represented in the larva, but frequently resorbed in the adult; at first in lateral contact, but afterwards separating so as to open out the tentacular vestibule, and expose the mouth.

CLASSIFICATION.

The "Stalked" Echinoderms, by which we understand the Crinoidea in their widest sense, have been regarded by some writers as constituting an independent class, by others as an "order" of the class Echinodermata. The latter view, which has been adopted by most of the later European systematists, was somewhat modified in the classification of Dr. P. H. Carpenter, who ranks the Stalked Echinoderms under the name "Pelmatozoa" as a "branch" of the "phylum" Echinodermata, and he makes the Crinoidea—*sensu str.*—and the Cystidea and Blastoidea, full classes, of equal rank with the Holothurians, Echinoids, Asteroids and Ophiurids.

The name Pelmatozoa, as stated by Carpenter (Chall Rep., p. 198), was introduced by Leuckart in an essay published in 1848, and more fully discussed in 1865, in his "Bericht über die wissenschaftlichen Leistungen in der Naturgeschichte der niederen Thiere." In the latter paper he subdivides the Echinodermata into three groups: the Pelmatozoa, to include the Stalked Echinoderms, *i. e.*, Crinoidea in the broadest sense; the Scytodermata, to embrace the Holothurians; and the Echinozoa, under which he placed the Urchins, Starfishes and Ophiurans.

That the Stalked Echinoderms and Holothurians are more distinct from each other, and from the three groups for which Leuckart proposed the name Echinozoa, than these are among themselves, cannot be denied, but it is questionable whether it is necessary or even desirable to express this in the classification, any further than by placing in juxtaposition the nearest allied groups. Too many subdivisions encumber the classification, and

as long as the Scytodermata and Echinozoa of Leuckart are not accepted, we think it unnecessary to establish a branch for the Pelmatozoa. In principle, however, we agree with Carpenter, and admit that the "Pelmatozoa" differ very essentially "in the presence of a stem, and in the consequent departure from the ordinary habits of an Urchin, Starfish or Holothurian. Whether sessile or provided with a stem, the Crinoid lies on its aboral surface instead of creeping about mouth downwards in search of food" (Chall. Rep., p. 193), and they differ also in having no locomotor organs in connection with the ambulacral system (Ibid., p. 188). All this, however, we think is sufficiently expressed by giving the Pelmatozoa the rank of a class, and placing them at the end of the list.

In our opinion there is no doubt that J. S. Miller proposed the name Crinoidea to designate exclusively the brachiate Crinoids, for he stated in his description (A Nat. Hist. Crin., p. 7), that "there proceed from the upper rim of the cup-like body five articulated arms, divided into tentaculated fingers," and among the species which he refers to them there is neither a Blastoid nor a Cystid. Unfortunately, however, later writers have used the name in a twofold sense, designating thereby the class and one of its subdivisions, until lately Zittel, in his Handb. der Palæontologie, to remedy this, proposed the name "Eucrinoidea" for the "Brachiata" *i. e.*, Crinoidea, *sensu str.*, and "Crinoidea" to take the name of the class, an arrangement which has since been accepted by De Loriol. To conform to Miller's idea, the new term should have been given to the class, and not to the subdivision. But as Leuckart had already proposed the collective name "Pelmatozoa," which has priority, and is a more appropriate term than Crinoidea, Zittel's scheme need not be discussed.

Carpenter has placed the Blastoidea and Cystidea on a level with the Crinoidea, making all three distinct classes, a rank to which we think they are not entitled. The three groups, according to our views, are mere modifications of the same plan which, so far as known, originated in the Cystidea, and of which the Blastoidea and Crinoidea are mere offshoots. The latter group, but especially the Blastoidea, are linked together with the Cystidea by such easy transitions, that among the earlier types it is difficult to draw any clear line of demarkation. We are unable to point out a single character that is not found exceptionally in

one of the other groups. We do not except the calicine pores or the pectinated rhombs, which are regarded as characteristic of the Cystids, nor the lamellar tubes beneath the ambulacra, which were thought to be restricted to the Blastoids. Even jointed arms occur in many Cystids, and in some of them they are connected with the radials in a similar manner as in the Crinoidea.

We do not wish to enter upon a discussion of the structural peculiarities of the Cystidea and Blastoidea, and, if we allude to them here, it is only to illustrate their close affinities with one another, and with the Palæocrinoidea. *Asteroblastus*, judging from the calyx, is a Cystid, but it has Blastoid ambulacra, Blastoid pinnules, associated with ambulacral and calicine pores. The same structure occurs in (?) *Agelacrinus Pustrewskii* Hofmann. On the other hand, the Blastoid genus *Codaster* has neither spiracles nor ambulacral pores; its hydrospires open out like those of certain Cystidea, and they do not underlie the ambulacra, but are placed alongside of them. *Codaster* was referred by Billings and Zittel to the Cystidea, but is now generally recognized as a Blastoid. *Stephanocrinus* has been variously described as a Crinoid, Blastoid and Cystid. As admitted by Carpenter, it has probably no hydrospires, and so far as known no calicine pores nor pectinated rhombs, but it possesses long Crinoid-like brachial appendages. *Caryocrinus*, which has been very generally regarded as a Cystid, has segmented pinnule-bearing arms like a Crinoid, and these are attached to the radials, but it has calicine pores, and numerous hydrospires along the inner floor of the calyx. *Porocrinus* has a calyx and arms like a Cyathocrinoid, but calicine pores like a Cystid. *Hybocystites* was described by Wetherby as a Cystid; by Carpenter as a transition form between Crinoids and Blastoids, but nearer the latter; while we consider it a Crinoid. Its arm structure is that of a Cystid, but it has apparently neither calicine pores, rhombs, nor lamellar tubes. The Crotalocrinidæ and Eucalyptocrinidæ probably have hydrospires within the calyx, *Cupressocrinus* and *Symbathocrinus* probably hydrospires underneath the ambulacra, and both have segmented arms.

These few examples, to which others might be added, will sufficiently show that neither the Blastoidea and Cystidea, nor the Crinoidea proper, form primary divisions like the Urchins, Starfishes or Ophiurans, but constitute subordinate groups of the

Pelmatozoa. Carpenter admits on p. 191 the close affinities between the Cystids and Blastoids, but the Crinoidea he takes to be a well-defined group "by having segmented arms attached to the radials, contrary to the Cystids and Blastoids in which there are either no arms at all, or structures of an entirely different nature from those of the true Crinoids." We have already directed attention to *Caryocrinus* and *Porocrinus* as having well-developed arms, similar to those of *Hybocrinus*, and also calicine pores. If we were to make the division between Crinoids and Cystids upon the arm structure, and did not make the calicine pores the principal distinction between those groups, we would also have to place among the Crinoidea *Comarocystites*, which has not only segmented arms but even pinnule-like appendages. Neither could we leave out *Glyptocystites* and *Pleurocystites*, in which the arms are long and lined with well-defined covering plates.[1]

Burmeister (Zoonomische Briefe, Leipzig, 1856, vol. i, p. 243) divided the "Crinoidea" into Anthodiata, among which he included the Cystidea and Blastoidea, and "Brachiata" with Tessellata, Articulata, Costata and the genus *Holopus*. This arrangement, leaving out the Costata, which probably are not Pelmatozoa at all, seems to us a very good one, and we find it convenient to adopt his divisions as "subclasses," substituting, however, for Burmeister's name Brachiata, Miller's older name Crinoidea. This enables us to discriminate between Palæocrinoidea and Neocrinoidea on the one side, and Cystidea and Blastoidea on the other, which, as we have stated, are more distinct from one another than the groups which we place under them. To make the Anthodiata and Crinoidea separate classes, on a level with the Urchins, would give to them too much importance. We doubt if Carpenter will claim them to be anything like as distinct groups as the Ophiurids and Starfishes, which by some systematists were regarded as mere subgroups of the

[1] The Cystidea have never been properly defined. They form in our opinion an assemblage of several groups of equal rank with the Blastoidea. S. A. Miller pointed out in the Cincinnati Journal of Nat. Hist., Dec. 1882, the Lichinocrinoidea and Agelacrinoidea as orders of the Crinoidea; the latter name, however, must be changed to "Edriasterida," as this has priority. It was proposed by Prof. Huxley in his classification of animals, London, 1869, p. 130 (Carpenter).

Stellerites. These, however, differ essentially in their mode of development, which can hardly be claimed for the Anthodiata and Crinoidea. We can only say of them that, as a rule, in the former the organs generally were contained within the calyx, whereas in the Crinoidea the generative and respiratory apparatus is almost entirely confined to the arms, and probably neither Blastoids nor Cystids had appendages united by paired muscular bundles. The Palæocrinoidea form parallel groups with the Blastoidea, both being descendants of the Cystidea; while the relations of Palæocrinoidea and Neocrinoidea are similar to those of Palæocrinoidea and Cystidea, and Cystidea and Blastoidea; but the Neocrinoidea, although they are of later descent, are equally well defined. In making these four groups orders of the Anthodiata and Crinoidea respectively, we place at the head of the list the Cystidea, as being the typical form, the Blastoidea next, and at the opposite end the Palæocrinoidea and Neocrinoidea.

In correspondence with Dr. Carpenter he has admitted that his classification tends to give an expression of well-marked differences between Crinoids, Cystids and Blastoids, which, as he stated on p. 191 of his Report, do not exist between the two latter, and we are authorized to state that he concurs with us in re-establishing Burmeister's Anthodiata and Brachiata, as we have practically done, the former to include as "orders" the Cystidea and Blastoidea, the latter the Palæocrinoidea and Neocrinoidea. We believe, therefore, that there is very little difference between us on this point.

Various other classifications have been proposed by different writers, for which we refer to the Challenger Report, pp. 186–196. The following classification will be adopted by us, viz.:—

Phylum, ECHINODERMATA.

Class, PELMATOZOA.

Subclass I, *Anthodiata.*	Subclass II, *Crinoidea* (*Brachiata*).
Order 1, CYSTIDEA, ETC.	Order 3, PALÆOCRINOIDEA.
Order 2, BLASTOIDEA.	Order 4, NEOCRINOIDEA.

Class, PELMATOZOA.

Definition.[1]—Echinoderms which are fixed either permanently

[1] This and the succeeding definition is taken from Carpenter (Chall. Rep., pp. 186), with a slight alteration in the first one which is indicated by italics.

or temporarily by the middle of the aboral surface. A jointed stem containing a neurovascular axis is usually present, but may be lost when maturity is reached; or in the case of a few sessile forms, remain altogether undeveloped. The apical system consists of a dorsocentral plate, basals and radials, with the frequent addition of underbasals and interradials. These plates form a cup, which either simply supports or more or less completely encloses the visceral mass, and often bears jointed appendages, the arms and pinnules.

An oral system, to some extent a repetition of the plates in the apical system, consisting of basals, radials and interradials, covers the peristome, but may be altogether resorbed, or be restricted to basals only. The anus either is located within the calyx, and surrounded by abactinal plates, or forms a part of the oral surface.[1]

The water vascular ring does not communicate directly with the exterior, and the lateral branches of the radial vessels (when present) are respiratory, but not locomotor in function.

Subclass, *Crinoidea.*

Definition.—Pelmatozoa, in which the radial plates of the calyx bear more or less branching arms. These consist of segments which are articulated by means of muscles and ligaments, and in most cases bear similar jointed appendages, the pinnules. The nervous system consists (1) of a central organ situated in the calyx, and fibres extending from it through the skeleton of the stem, arms and pinnules; (2) of a circumoral ring and radial extensions which are in close relation with the ciliated epithelium of the ambulacral grooves. These are more or less extensively distributed on the ventral surface of the disk, arms and pinnules; and are bordered by groups of tentacles which alternate on opposite sides. When they are absent, the radial water vessels give off no tentacular branches. The water vascular ring opens by five or more water tubes into the body cavity, which itself communicates with the exterior by a corres-

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[1] Carpenter's version: "An oral system, consisting of a central plate (orocentral) and five orals, is developed above the peristome of the larva to a very variable extent, and may be either altogether resorbed, or reach a high degree of importance by the appearance of additional plates so as to form a vault or *tegmen calycis*. The anus is situated on the oral surface, which may be bare, or more or less covered by calcareous plates."

ponding number of water pores. The mouth is central, except in a *few genera*, and the anus subcentral or excentric. The genital glands are lodged in the lower parts of the arms, but are usually fertile only in the pinnules.

The Subdivisions of the Palæocrinoidea.

Among the Palæocrinoidea we recognize three great divisions, which on the whole correspond to our former groups, Sphæroidocrinidæ, Ichthyocrinidæ and Cyathocrinidæ. These groups, which are divisible into definite subgroups, will be ranked by us as suborders of the Palæocrinoidea, and the subgroups as families. The three suborders, for which we have proposed the names *Camarata*, *Articulata* and *Inadunata*, are distinguished from one another principally by the mode of union among the calyx plates, and the condition of the arms as to whether their lower plates constitute a part of the calyx, and as such enclose the visceral cavity, or form parts of the free arms. These groups are not only well defined in nature, as shown by the fact that they are so readily recognized, but they are also most convenient for all descriptive and comparative work.

When we first defined the three groups (Rev., i and ii), we laid the greatest stress upon the construction of the ventral surface, which, as we stated, offered most excellent characters for their separation; but as the modifications which take place among them, to a large extent, result from the conditions of calyx and arms, we regard the structure of their ventral side as of subordinate rank. This necessitates a re-description of those groups, especially as our present views upon the ventral plates generally differ essentially from those previously held by us.

We have stated that the so-called "orals," upon which the "Cyathocrinidæ"—the Inadunata of our new classification—were at that time principally founded, are interradials, which attained their ventral position by being in lateral contact, in place of resting laterally against the lower arm plates. The construction of the ventral surface in the earlier Inadunata thereby became fundamentally identical with that of the "Sphæroidocrinidæ," except that the latter attained subsequently a larger number of interradials. In the later Inadunata the ventral structure is very different; indeed, so much so that the two sections according to our former views should have been distinctly separated. This we

had contemplated, but we encountered great difficulties, as the two forms run very closely from one into the other. Even the ventral sac, the best distinguishing character, undergoes all possible modifications. It dwindles down to almost nothing in some of them, and its porous nature is sometimes very indistinctly developed or even unrepresented. We regard these modifications, as they occur in palæontological times, as representing various stages of development in the history of this group, and as good generic characters, but do not attach to them the importance we did before. We have, however, placed the genera in which a ventral sac is developed as a group by themselves, to separate them from those in which it is absent. The latter group, which represents the larval form, will be designated by us as "*Larviformia*" the former as "*Fistulata.*"

Instead of the name Sphæroidocrinidæ, which is objectionable for several reasons, we propose to use *Camarata*, under which we have placed several additional groups. To the *Articulata* (nobis, not Müller or Miller), which we restrict to the *articulated Palæocrinoidea*, we refer the Ichthyocrinidæ and Crotalocrinidæ. If there is any objection to re-establishing Müller's name, which has been generally discarded, we might change Articulata into "Articulosa." We think, however, we are fully entitled to adopt the former, as the Crinoids which we refer to them are true Articulata in Müller's sense. We place the Camarata, which we regard as the typical form of the Palæocrinoidæ, at the head of the list, the Articulata next, and the Inadunata, which in some respects approach the Neocrinoidea, at the opposite end.

The CAMARATA embrace all Palæocrinoidea in which the plates of the test are solidly united by suture, and in which the lower arm plates are incorporated by means of interradial plates so as to form a part of the calyx. The underbasals are frequently undeveloped. The basals of monocyclic genera are variable in number, five being the exception. The primary radials consist generally of three plates to each ray, rarely of two or four. There is always at least one secondary radial, which may give off the free arms or support others, and frequently radials of higher orders. Interradials numerous, or not less than two; the first one resting upon the sloping upper sides of the first radials, or alternating with them. The interradials, together with the interaxillaries and anal plates, separate the rays and their sub-

divisions, and cover the greater part of the ventral surface up to the summit plates, or the whole of it including the latter. The free arms are simple or branching, and with a few exceptions biserial, uniserial only in their immature state, permanently only in a few Silurian genera. The articulation of the arms is primitive, and dorsal canals have never been observed. All have pinnules, which as a rule are closely folded together. The anus is surrounded by solid plates, suturally connected; its position is excentric, except in the Eucalyptocrinidæ.

The summit plates are largely developed, and consist in all Carboniferous, and in most of the Devonian genera, of an undivided oral plate, proximals, and frequently one or more radials; in most of the Silurian forms, however, of orals only, and even these may be covered by interradials. The disk is subtegminal, but sometimes the covering pieces enter the outer surface, when they take the condition of surrounding plates. The Camarata have small openings along the brachial zone, by means of which the water for respiration entered the body.

To the ARTICULATA we refer all Palæocrinoidea in which the test is pliable. The calyx extends to the lower arm joints, and the plates are united by articulation, and not by suture. Underbasals are always represented; they are small, being frequently covered by the column, and consist of either three or five plates. The number of primary radials varies from two to seven or more, and also the number of the higher orders is very variable. The radials of different rays are either in contact laterally or connected by the help of interradials. In the former case, frequently, a smaller number of radials alternates with a larger one, and the plates of one ray rest with their upper sloping sides against the lower sloping sides of their fellows of adjoining rays, or *vice versa*. When the radials are separated by interradials, these either extend to the basals, or rest against the upper sloping sides of the first radials. In some cases, however, the interradials are restricted to the ventral surface. The form of the calyx varies from almost strictly pentamerous to bilateral symmetry, but it sometimes becomes irregular, owing to the interposition of an azygous plate. Some species have no anal plate dorsally. The radial and arm plates are united horizontally by muscles and ligament, or perhaps in some cases by ligament only. The lateral face of the radials and those of the interradials are provided with deep ligamental fossæ. The arms are closely folded together,

and sometimes connected laterally by a membranous substance. The ventral surface, so far as known, is composed of interradial plates; it forms a pliable vault, which extends to the free rays, and probably covers not only the disk, but also the summit plates. The Crotalocrinidæ have no anambulacral pieces, but possess hydrospires within the calyx.

The INADUNATA are subdivided into *Larviformia* and *Fistulata*. They include all Palæocrinoidea in which the arms are free from the first radials. Their calyx is comparatively small; composed exclusively of basals, frequently underbasals, five radials, five interradials, and one or two azygous plates. The proximal ring of plates, whether basal or underbasal, is composed of five, or less frequently, three plates. The radials are laterally connected except at the posterior side, where they are separated by an azygous and anal plate, if these have not been resorbed. The presence of the azygous plate gives to the calyx a very irregular outline. The interradials are located ventrally; they rest against the upper ends of two adjoining radials, and join along their lateral margins.

The ventral covering of the LARVIFORMIA consists of comparatively few pieces, among which generally the combined muscle plates form a conspicuous part. The central space is covered either exclusively by interradials, or these enclose an oral plate, which in some of the higher forms is surrounded by proximals. The disk is subtegminal in place of being extended into a lateral sac. The anal opening either penetrates the interradials, or is placed intermediate between two radials or their appendages. Respiration took place by pores along the arm furrows, which probably communicated with hydrospires.

In the higher organized FISTULATA the perisome is partly or wholly exposed, the interradial plates either cover the perisome, or this partly covers them. In the latter case the summit plates may be resorbed, in the former they are largely represented; but in either case portions of the disk penetrate the calyx posteriorly by passing out through the anal opening. These portions form either a balloon-shaped or a tubular sac, composed of well-defined plates, closed at the end, but perforated over the surface by pores along the suture lines; the pores penetrating the lateral edges of the plates. Respiration took place by means of the pores along the perisome.

this species underbasals are known to be absent, and they have four in place of five basals. Any difference in the number of basals has been generally considered a good generic distinction, and this makes *Xenocrinus*, undoubtedly, a good genus. But in which group shall we place it? Together with *Reteocrinus* or *Glyptocrinus*? Together with species in which the interradials rest upon the basals, and which have well developed underbasals, or with species destitute of underbasals, and with their interradials, as in *Glyptocrinus*, resting upon the first radials?

In Part II we maintained th[illegible], as a rule, the presence or absence of underbasals should [illegible]onsidered of more than generic importance, and this we m[illegible] principal distinction between Actinocrinidæ and Rhodocrinidæ. We pointed out, however, that in these families there are several genera, among the earlier types, which are closely con[illegible]l by transition forms, and shade almost imperceptibly from [illegible]nto another. We even thought it possible that species of the [illegible]me genus might possess underbasals in a rudimentary way, [illegible]e those plates might be totally absent in others. This is n[illegible]nfirmed by our later investigations, but it is nevertheless by [illegible] means an easy task to separate some of the earlier genera upon this character, as there are frequently other important features by which they are much more closely connected with other groups. In proof of this we need only refer to *Glyptocrinus Richardsoni*, provided this really possesses no underbasals, as Miller asserts, and to *Reteocrinus O'Nealli*, in which they are very conspicuous. As the two species are almost identical in every other respect, it would seem doubtful policy to refer them to distinct families upon this character alone. S. A. Miller evidently experienced the same difficulty, for his Glyptocrinidæ include genera of both forms. Zittel, De Loriol, and all preceding writers, make the presence of underbasals a full family distinction, and all their Glyptocrinidæ and Rhodocrinidæ are said to have underbasals.

Diversities in the distribution of the interradial plates of the calyx have been generally taken to be of minor morphological importance; but at the same time they have been considered good characters for distinguishing genera. S. A. Miller alone has placed in the same genus species, which in this respect show the greatest possible contrast. It is, however, rather singular that he applies this rule only to the "Glyptocrinidæ," while in other

groups he considers such difference to be at least of generic importance, and what is more singlar, he even constructed thereon a whole family. His Melocrinidæ differ from his Actinocrinidæ mainly in having all five interradial spaces arranged almost uniformly, and they generally have four basals. That Miller did not make the number of basals the distinctive character, is very evident, or he would have arranged his *Xenocrinus penicillus* and "*Compsocrinus*" *Harrisi* among the Melocrinidæ. On the contrary, he placed these species under distinct genera; while he referred *Glyptocrinus decadactylus* and *Reteocrinus Richardsoni* to the same genus, although these two differ in exactly the same way as the two former species.

One is curious to know upon what ground Miller based his Glyptocrinidæ. Not upon the underbasals, nor upon the relative number of basals; neither upon the ridges along the radials, for these are absent in *Cupulocrinus* and *Lampterocrinus*, and certainly not upon the ornamentation, which he asserts does not hold good even among those genera. They are united by no single character, and since it has been clearly proved that *Glyptocrinus* has no underbasals, this genus no longer falls within the Rhodocrinidæ, which were fundamentally based upon the presence of those plates, and must be referred to the Actinocrinidæ. That *Glyptocrinus* was in many respects closely allied to the Actinocrinidæ, subdivision Melocrinites, has been shown already in Part II, and several species were at first described under *Glyptocrinus*, which we have since referred to *Mariacrinus*. Among these is *Gl. Harrisi*, for which Miller lately proposed the genus *Compsocrinus*. The generic definition of *Compsocrinus* is partly based upon inaccurate observation, for the interradials of all five sides rest upon the edges of the first radials, and not one of them upon a basal, as figured by Miller in his diagram pl. 11, fig. 4, a.

It has been stated in Part II, p. 185, that the interradials of all known Actinocrinidæ, except sometimes those of the azygous side, rest upon the first radials, and this is the case in *Glyptocrinus* and "*Compsocrinus*." We find an apparent exception to this rule, if we make the absence of underbasals the controlling family character, in the genus *Xenocrinus*, and perhaps in *Glyptocrinus Richardsoni* and *Gl. Pattersoni*, in which underbasals have not been observed. The two latter species agree in all essential particulars with *Xenocrinus*, in which we include not only Miller's

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[illegible] arranged [illegible]
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[illegible] es, in which [illegible]
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succeeded by [illegible]
[illegible] nates, as here [illegible]
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[illegible] who intimates that [illegible]
[illegible] arily be regarded [illegible]
[illegible] the larger and [illegible]
[illegible] the Rhodocrinidae [illegible]
[illegible] occur in none of the later [illegible]
[illegible] the very earliest Silurian [illegible]

recognizing them as a distinct family, which we propose to call *Reteocrinidæ*.

Now, having referred the genus *Glyptocrinus* in its typical form, and "*Glyptocrinus*" (*Compsocrinus*) *Harrisi* Miller, = *Mariacrinus Harrisi*, to the Actinocrinidæ or their allies, *Reteocrinus*, *Xenocrinus*, and our new genus *Canistocrinus* to the Reteocrinidæ, there remain for consideration among species with underbasals, or Rhodocrinidæ, as they were previously called, two other groups:

(*a*.) Species, in which all five primary interradials meet the basals, forming a ring of ten plates with the first radials.

(*b*.) Species, in which the first anal plate only rests upon the basals, the interradials upon the edges of the first radials. The first group comprises the genera: *Archæocrinus*, our new genus *Rhaphanocrinus*, *Lyriocrinus*, *Rhipidocrinus*, *Thylacocrinus*, *Anthemocrinus*, *Rhodocrinus*, and *Ollacrinus*; the second *Glyptaster*, *Dimerocrinus*, *Ptychocrinus* and *Lampterocrinus*. The former group agrees with our subdivision *Rhodocrinites*, except *Archæocrinus*, which we had previously arranged under Glyptocrinites; the latter corresponds with our former Glyptasterites.

It might be as well, perhaps, to let these groups remain as subdivisions of the Rhodocrinidæ; but, as it is desirable that the families proposed by various authors in the different classifications should be made to correspond as far as possible, we follow Zittel, and rank them as full families. The first, as embracing the typical genus, will be *Rhodocrinidæ*. Zittel's name, Glyptocrinidæ, however, cannot be used for the other group, since it is known that *Glyptocrinus* has no underbasals. We propose in its place the name *Glyptasteridæ*, *Glyptaster* being one of its most characteristic types.

These divisions are substantially in conformity with the views of Carpenter, expressed in his paper on *Thaumatocrinus*, p. 929. He approves Zittel's division into Glyptocrinidæ and Rhodocrinidæ, but acknowledges at the same time "that *Glyptocrinus* has decided affinities with the Actinocrinidæ." His views upon the irregular plates of *Reteocrinus* have already been quoted. The rounded ridges along the radials, as they appear in *Reteocrinus* and *Xenocrinus*, are more than mere ornamentations. They seem to have contained tubular passages which, perhaps, may represent the axial canals, while the more angular ridges of *Glyptocrinus*, *Glyptaster*,

etc., must be considered simply as an ornamentation of the calyx. They represent, as stated by Carpenter, "a character of altogether minor importance as compared with the morphological difference between the lateral union and the isolation of the radials."

In Part II we have placed under *Actinocrinidæ* all Crinoids without underbasals, in which the interradial plates are connected by suture, and the basals support the radials, and frequently a large anal plate, but none of the regular interradials. This excluded the allied genus *Acrocrinus*, in which basals and radials are separated by a large number of accessory pieces. We excepted also the *Calyptocrinidæ* with *Eucalyptocrinus* and *Callicrinus*, which differ essentially in their vault structure, and the *Barrandeocrinidæ* for other reasons to be explained hereafter.

The Actinocrinidæ, as they were defined by us, comprise a well-defined natural group; and we find it difficult to subdivide them, unless it be upon the presence or absence of an anal plate in line with the first radials, *i. e.*, the bilateral symmetry of the one group as contrasted with the more or less pentamerous symmetry in the other. In making this division, we place the Stelidiocrinites and Melocrinites with their almost regular symmetry in the one group, and the Agaricocrinites, Periechocrinites, Actinocrinites and Batocrinites in the other, the former as *Melocrinidæ*, the latter as *Actinocrinidæ*.

Rœmer, Lethæa Geogn., 1855 (Ausg. 3), p. 228, distinguished Melocrinidæ from Actinocrinidæ, the latter on account of their larger azygous interradius, and having three in place of four basals. Zittel partly recognized these groups, but added to the Melocrinidæ *Scyphocrinus* Zenker (not Hall), *Corymbocrinus* and *Abacocrinus*, the latter with an anal plate upon the basals, thus proving that he made the number of basals the distinctive character. He divided our Actinocrinidæ into the families *Briarocrinidæ*, *Carpocrinidæ*, *Dimerocrinidæ*, *Actinocrinidæ* and *Polypeltidæ*.

Our *Platynicridæ* were subdivided into Platycrinites and Hexacrinites, the one with strictly pentamerous symmetry in the calyx, the other bilateral. The two groups are easily recognized, and will be continued, but ranked as families.

The Platycrinidæ have been described by us and other writers as having a single interradial plate in contact with the radials.

This was based upon an incorrect understanding of the plates. That it is not the case in *Platycrinus* is readily seen by our figures on pl. 7. Even the most simple form has three interradials, horizontally arranged, all supported by the first radial plates, and we are convinced that three, or a greater number of plates, are found in all other Platycrinidæ, and all Hexacrinidæ. Wherever we have observed them, the middle plate is larger, and rests upon the juncture of two first radials, the outer ones upon their upper face, meeting laterally the higher radials. The larger number occurs in forms with flattened disc and wide, spreading rays.

The presence of three or more pieces in the first row, which evidently represent the first, second, and perhaps third ranges of interradials in other groups, is morphologically of considerable importance, as it seems to have produced, to a large extent, the structural peculiarities of the two families. It is evident that, owing to the great width of the interradial areas, the succeeding radials could make no connection with the higher interradials, and the rays thereby became isolated, and remained permanently in a more or less embryonic state. Three interradials seem to have been represented also in *Coccocrinus*, as shown in Roemer's figure 5[c] of *C. bacca*, although they are not figured in his *Coccocrinus rosaceus*.

We also refer to the Camarata the genus *Barrandeocrinus*. It was made by Angelin, Zittel and De Loriol the type of a distinct family, and this seems to be warranted by its exceedingly strange form, produced principally by the construction of the arms and the arrangement of the plates at the ventral side, although the plates along the dorsal side are arranged similarly to those of the Actinocrinidæ.

The Camarata, according to our classification, fall into ten families:

A. RETEOCRINIDÆ. Base monocyclic or dicyclic. Basals 4 or 5. Radials folded into strong tubular longitudinal ridges along the median line of the plates. Interradial and interaxillary areas deeply depressed; resting upon the basals. They are composed of a large number of ill-formed immovable pieces, which continue to the ventral side, almost completely covering the interpalmar areas, leaving but a small oral plate at the centre. Azygous side wider; divided by a vertical row of rather large

anal plates, which extend to the anal aperture. Arms single-jointed; pinnules strong. Anus subcentral. Column circular or angular.

B. RHODOCRINIDÆ. Base dicyclic. First radials separated from one another by the first interradials, with which they form a ring of ten plates around the basals. Interradial areas composed of well-formed plates, definitely arranged; azygous side scarcely distinct. The interradials in all earlier forms along the ventral side are arranged like those of the Reteocrinidæ, and the proximals are probably unrepresented; but in the later ones proximals are well developed. Anus subcentral. Column circular or obtusely pentangular.

C. GLYPTASTERIDÆ. Base dicyclic. First anal plate resting on the basals, but the first interradials not touching them. Succeeding interradials arranged as in the Rhodocrinidæ. Those upon the ventral surface are sometimes composed of larger plates than in the preceding groups. Anus subcentral. Oral piece and proximals well represented. Column circular or pentangular.

D. MELOCRINIDÆ. Base monocyclic. Basals 3 to 5. Neither anal nor interradial plates touching the basals; the latter in contact with radials only. Interradial areas composed of numerous plates; those upon the dorsal side large, regularly arranged, those along the ventral surface frequently small and irregular. Oral plate generally surrounded by proximals. Anus subcentral. Column circular, rarely angular.

E. ACTINOCRINIDÆ. Base monocyclic. Basals 3, rarely 4. First anal plate resting on basals, the first interradials upon the sloping sides of the first radials. The interradials together with the interaxillaries, anal plates and proximals, form a solid vault over the disk, rarely exposing any of the covering plates. Anus subcentral. Column circular.

F. PLATYCRINIDÆ. Base monocyclic. Basals unequal. Neither anal nor interradial plates touching the basals. First radials extremely large, forming with the basals almost the whole dorsal aspect of the calyx. Second radial small and short, and likewise the higher orders of radials, which in place of being connected by interradials, are formed into lateral branches or free appendages. Interradials three at least, generally more; all located more or less ventrally. The lower range contains no special anal

plate. It consists of from three to five pieces, transversely arranged; the middle one larger, resting upon the sloping upper ends of two first radials; the outer ones abutting against the large primary and smaller succeeding radials. Oral piece large, generally surrounded by proximals, which are very prominent. Covering plates frequently exposed upon the surface. Anus subcentral. Column circular or oval.

G. HEXACRINIDÆ. Base monocyclic. Basals 2 or 3. First anal plate resting on basals, and similar in form to first radials; other plates arranged as in Platycrinidæ. Calyx with similar arm-like extensions. Column circular.

H. ACROCRINIDÆ. Base monocyclic. Basals 2, separated from the radials by a wide belt of small plates, which are arranged in rings around the basals, and occupy the greater part of the dorsal side. Radials 3×5, increasing in size upwards, all isolated laterally. Interradials in two rows; two plates in the lower series, one only in the upper, but the latter larger than the two others. Azygous interradius comparatively much wider, and composed of twice the number of pieces, in addition to the anal plates which form a vertical line. Column circular.

I. BARRANDEOCRINIDÆ. Base monocyclic. Basals 3. First anal plate resting on basals; the interradials upon the sloping upper sides of the first radials. Arms recumbent; united laterally by their pinnules, and together with these forming a solid integument around the calyx. Column circular, large.

J. EUCALYPTOCRINIDÆ. Base monocyclic. The dorsal side uniformly composed of 4 basals, 3×5 primary radials, 2×10 secondary radials, 3×5 interradials, and 1×5 interaxillaries, there being no anal plates. The ventral side consists of 5 large interradials, 5 similar interaxillaries, and 10 small trigonal interbrachial pieces, which form a ring around the dorsal cup, and are succeeded by the summit plates. The summit plates form a neck-like prolongation. They consist of 4 large proximals which constitute a ring by themselves, of two small proximals, and the oral plate. The latter is bisected and pushed to opposite sides by the anal opening, which is strictly central. The plates of the ventral side are formed into 10 compartments for the reception of ten pairs of arms. Column circular.

FAMILY I.—RETEOCRINIDÆ W. & Sp.

RETEOCRINUS Billings.

1881. W. & Sp., Rev. II., p. 191.
1883. W. & Sp. Amer. Journ. Sci., vol. xxv (April), p. 256–268.
1884. P. Herb. Carpenter, Phil. Trans. Royal Soc., Pt. III, 1883, pp. 919–933.
Syn. Glyptocrinus (in part), Miller; Journ. Cincin. Soc. Nat. Hist., vol. v, April, 1882.
Syn. Gaurocrinus Miller (in part). Ibid. vol. vi, December, 1883.

Reteocrinus is readily distinguished from the other Reteocrinidæ by its well developed underbasals, which extend beyond the limits of the column. From our former list we withdraw *Reteocrinus Baeri*, which is a *Xenocrinus*, and *Reteocrinus Richardsoni* Wetherby, which we make the type of our new genus *Canistrocrinus*.

One more species must be added:

*1883. Reteocrinus magnificus (S. A. Miller), Gaurocrinus magnificus, Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 230, Pl. 9, fig. 2.—Hudson River gr.—Lebanon, O.

CANISTROCRINUS, nov. gen.

(*κανιστρον*, a willow basket; *κρίνον*, a lily.)

Syn. *Glyptocrinus* (in part) S. A. Miller, 1883, Journ. Cincin. Soc. Nat. Hist., vol. vi., p. 226.
Syn. *Reteocrinus* (in part) W. & Sp., Amer. Journ. Sci., vol. xxv, p. 268.

Generic Diagnosis.—In general aspect closely resembling *Reteocrinus*. The radial ridges strong, tube-like; the interradial spaces deeply depressed. Symmetry decidedly bilateral.

Underbasals perhaps indistinctly developed, more probably altogether absent. Basals five, truncated above for the reception of the lower series of interradials. Primary radials 3×5, of nearly equal size; the first and third similar in form. The ridges of the former branching downward toward the basals; those of the latter upward toward the secondary radials, which they follow until these turn into free arm-plates. Arms branching or simple; composed of single joints, which give off rather strong pinnules.

Interradial spaces composed of numerous small pieces without definite arrangement. The plates rest upon the basals, separat-

ing all five rays from the base up. With the increase of interradials and interaxillaries by age, which seems to have been going on continually in the specimen, more arm-plates, *i. e.* radials, were gradually incorporated into the calyx, involving the proximal pinnules, the plates of which are easily recognized from surrounding interradial and interaxillary pieces by being more prominent. Azygous interradius wider than the four others. It has an elevated ridge, composed of rather large anal pieces, which are longitudinally arranged and have somewhat the appearance of radials. The interaxillary areas are depressed, even deeper than the interradial ones, and they consist of similar plates. The ventral side has not been observed, but was evidently constructed as in *Xenocrinus* and *Reteocrinus.*

We place here the following species:

*1882. **Canistrocrinus Pattersoni** (S. A. Miller), **Glyptocrinus Pattersoni,** Journ. Cincin. Soc. Nat. Hist., vol. v (July), Pl. 3, figs. 2, 2 a. Ibid., vol. vi, Decbr. 1883, p. 226.—**Reteocrinus Pattersoni,** Wachs. and Sp., 1883, Amer. Journ. Sci., vol. xxv, April, 1883, p. 266. Utica Slate, Cincinnati, O.

*1880. **Canistrocrinus Richardsoni** (Wetherby). Type of the genus.—**Glyptocrinus Richardsoni,** Journ. Cincin. Soc., Nat. Hist., vol. ii, Pl. 16, figs. 1. 1 a. W. & Sp., 1881.—**Reteocrinus Richardsoni,** Rev. ii, p. 193; also Amer. Journ. Sci. vol. xxv, p. 266.—Miller, **Glyptocr. Richardsoni,** 1883, Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 226. Hudson River gr., Clinton Co., O.

XENOCRINUS S. A. Miller.

(Pl. 6, fig. 2.)

1881. S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. iv.
1881. W. and Sp. Revision ii, p. 184.
1883. W. and Sp. Amer. Journ. Sci., vol. xxv, p. 266.

Xenocrinus is closely allied to *Canistrocrinus*, from which it differs in having four in place of five basals, and a quadrangular column.

Generic Diagnosis.—Base monocyclic. Basals four, forming combined a shallow decagonal cup, which upon five of its sides supports the five radials, and alternately upon each of the five other sides a series of small interradial pieces. This arrangement gives to the basals, owing to their abnormal number, a very irregular form, no two of them being alike. The axial canal in this genus, notwithstanding it has but four basals and a quadranglar stem, is pentangular, its angles directed interradially. In all other respects, including the ventral covering, *Xenocrinus*

agrees with *Reteocrinus* and *Canistrocrinus*, to which we refer for further particulars. We place in this genus also "*Glyptocrinus*" *Baeri* Meek, which we have heretofore referred to *Reteocrinus*, not knowing the construction of its basal portions. It has not only four basals, but fundamentally a quadrangular column, the more or less cylindrical outline being caused by knife-like lateral extensions along the joints; its cross-section shows the nucleus to be strictly quadrangular.

Geological Position, etc.—Hudson River group of the Ohio valley.

*1872. **Xenocrinus Baeri** (Meek), **Glyptocrinus Baeri**, Amer. Journ. Sci. iii (Ser 3), p. 260; also 1873, Geol. Rep. Ohio, Paleont I, p 37, Pl. 2, fig 1 a, b.—S. A. Miller, 1880, Journ. Cincin Soc. Nat Hist., vol. iii, Pl 7, fig. 4—**Reteocrinus Baeri** W. & Sp., 1881, Revision ii, p. 193; also Amer. Journ. Sci., vol. xxv, p 266—**Glyptocr. Baeri** S A. Miller, 1883, Journ. Cincin. Soc. Nat. Hist., vol vi, p. 226—Hudson River gr., Ohio valley.

1881. **Xenocrinus penicillus** S. A. Miller. Type of the genus. Journ. Cincin. Soc. Nat. Hist., vol. iv (April), Pl. 1, fig. 3, and ibid July), Pl. 4, fig. 6.—Hudson River gr. Waynesville, O.

FAMILY II.—RHODOCRINIDÆ Roemer.

(Emend., Zittel; emend., W. and Sp.)

ARCHÆOCRINUS W. and Sp.

1881. W. and Sp. Revision, ii, p. 189.

1883. S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 217.

Syn. *Lyriocrinus* (S. A. Miller not Hall), 1882, Journ. Cincin. Soc. Nat. Hist, vol. v.

Mr. Walter R. Billings informs us that all the species which we referred to *Archæocrinus*, possess a special anal piece placed between the interradials of the second series. In Part II, p. 190, we erroneously stated that the anal interradius could not be distinguished from the four others, and we are obliged to Mr. Billings for making this correction. We find it confirmed by some interesting specimens which we recently collected from the Trenton limestone near Knoxville, Tenn. Most of these specimens represent Miller's "*Lyriocrinus*" *sculptus*, which was supposed to come from the Niagara group, but which evidently came from a lower horizon. Our specimens were found associated with *Hybocrinus* and other characteristic *Lower* Silurian fossils. *Lyriocrinus sculptus* Miller, or, as we call it, *Archæocrinus sculptus*, is

smaller than any of the Canadian species. It has but one secondary radial, and fewer and larger interradials both dorsally and ventrally, but otherwise agrees well with those types. It probably represents paleontologically a younger stage of that genus, for the arms are free from the first secondary radial. In *Lyriocrinus* the arms proceed upward in a straight line with the walls of the calyx, the arm openings are located ventrally and are arranged at nearly equal distances from each other; while in *Archæocrinus sculptus* the arms extend out laterally in the form of free appendages. In the former the interradials of the ventral side rest against the inner edges of the dorsal cup, the so-called "vault" being perfectly flat; in the latter the vault is elevated and the interradials along the ventral side are so closely intermingled with the dorsal ones, that no dividing line can be distinguished.

In *Archæocrinus desideratus*, which is a good typical form of the genus, there are twenty or more interradials beneath the horizon of the arms, and these are succeeded by a much larger number of minute pieces at the ventral side, all of which, from the basals up, decrease in size to the oral pole. There are no large plates to represent the proximal dome plates, and hence no orals if these were represented by the proximals as contended by Carpenter. The interradial and interaxillary spaces in the dome are depressed, thereby producing along the surface somewhat irregular ridges, which follow the direction of the subtegminal ambulacral tubes.

The depressed globular form and the wide interradial spaces of the calyx are characteristic features of *Archæocrinus*, which distinguish it readily from all other Silurian Rhodocrinidæ.

Some of our specimens of *Archæocrinus sculptus* have beneath the first interradial plate, resting upon the basals, two small additional plates. As these are present only in the larger specimens, and totally absent in the smaller ones, in some of them developed in a most rudimentary way, sometimes only in one or two of their rays, it is evident that they are the result of extravagant growth, and not true interradial plates. They seem to us equivalents of the small accessory pieces between basals and radials in *Acrocrinus*, in which they attain a much more profuse development, occupying the greater part of the calyx.

We note here the following additional species:

1884. **Archæocrinus desideratus** Walter R. Billings MS. (The description will appear in the Transactions of the Field Naturalist's Club of Ottawa.)

*1880. (?) **Archæocr. globularis** Nichols. and Ether., Silur. Fossils Girvan Distr., p. 329, Pl. 22, figs. 9-11.—Craighead limestone.

*1882. **Archæocrinus sculptus** (S. A. Miller), **Lyriocrinus sculptus**, Cincin. Journ. Nat. Hist., vol. v, p. 217, Pl. 3, figs. 6 a, b.—Trenton limest. Knoxville, Tenn.

Syn. **Lyriocrinus sculptilis** S. A. Miller. Name preoccupied.

RHAPHANOCRINUS nov. gen.

(ῥάφανος, a radish; κρίνον, a lily.)

Syn. *Glyptocrinus* Walcott (in part), not Hall, 1883, New Spec. of Foss. from Trenton gr. of N. York, p. 2. (Abstract from the 35th Rep. N. York State Museum Nat Hist., N. York.)

The species upon which the genus *Rhaphanocrinus* is proposed, was referred by Walcott, with some doubt, to *Glyptocrinus*. Like that genus, it has regularly arranged interradial plates, but these rest upon the truncate upper side of the basals, not upon the sloping sides of the first radials as in that genus; besides it possesses underbasals. The latter plates were not observed by Walcott; they are evidently small, and covered by the large column or hidden within the basal concavity. That underbasals were present, is clearly seen by the angular form of the first radials, and by the form, size and position of the basals.

Rhaphanocrinus is closely allied to *Archæocrinus*, from which it differs in having the arms constructed of a single series of quadrangular plates, and in having simple, in place of branching, arms. It also resembles *Dimerocrinus* in its general aspect, but is readily distinguished by the position of the interradial plates, and by having the arms constructed of a single series of plates. It differs from *Anthemocrinus*, with which it has probably the closest affinities, in the entirely distinct arm structure.

Generic Diagnosis.—Calyx short, truncate below; interradial spaces slightly depressed.

Underbasals small, not visible in a lateral view, and more or less hidden by the column. Basals large, hexagonal, the upper side truncate for the reception of the first interradials.

Primary radials 3 × 5, large; the first and third nearly alike in form. Secondary radials two or more, quadrangular; gradually decreasing in height and passing into arm plates.

Interradials numerous; those of the ventral side smaller. Interaxillary plates few. Summit plates, and form of anus unknown.

Arms stout, long, simple; composed of a single series of quadrangular plates, which give off alternately strong pinnules. Column large; cylindrical.

The type of the genus, and only known species is:

*1883. **Rhaphanocrinus subnodosus** (Walcott), Glyptocrinus (?) subnodosus, 35th Rep. N. York State Mus. Nat. Hist., Pl. 17, fig. 3.—Trenton limest. Trenton Fall, N. Y.

LYRIOCRINUS Hall.

(W. and Sp., Revision II, p. 203.)

Not *Lyriocrinus* S. A. Miller, 1882, Journ. Cincin. Soc. Nat. Hist., vol. v, p. 217.

(?) **SAGENOCRINUS** Angelin, Rev. II, p. 201.

RHIPIDOCRINUS Beyrich, Rev. II, p. 205.

THYLACOCRINUS Oehlert, Rev. II, p. 207.

1879. *Thylacocr. Vanniosti* Oehlert, Extr. du Bull. Soc. Géol. de France (Ser. 3), vii, Pl. i, fig. 1; also 1882, ibid. vol. x, p. 359, fig. 1.—Devonian. St. Germain, France.

ANTHEMOCRINUS W. and Sp. Rev. ii, p. 208.

RHODOCRINUS Miller, Rev. ii, p. 209.

1882. *Rhodocr. coxanus* Worthen, Bull. i, Illinois St. Mus. Nat. Hist., p. 80; also Geol. Rep. Illinois, vii, p. 305.—Keokuk limest. Keokuk, Iowa.

OLLACRINUS Cumberland, Rev. ii, p. 213.

Family III.—GLYPTASTERIDÆ W. and Sp.

PTYCHOCRINUS nov. gen.

(πτύξ a fold; κρίνον a lily).

Mr. S. A. Miller has arrayed a number of species under a proposed genus *Gaurocrinus*, which, like his *Glyptocrinus*, embraces a heterogeneous assemblage of forms. It contains species of *Reteocrinus*, *Glyptocrinus*, and a new form with good generic characters, in our opinion, for which we should be very glad to retain Miller's name, if he had not expressly taken as its type Hall's *Glyptocrinus O'Nealli*, which is a typical *Reteocrinus*. We are, therefore, obliged to adopt a new name, and propose *Ptychocrinus*, for the reception of his *Gaurocrinus splendens*, and *G. angularis*, together

with Hall's *Glyptocrinus parvus*, which, evidently, according to Hall's figure (but not Meek's), has the same characters.

We cannot agree with Miller that Wetherby's *Reteocrinus gracilis*, in which ill-formed interradials separate the radials down to the base, and in which the basals are squarely truncated above and form the base of the interradial spaces, is a synonym of *Glyptocrinus angularis*, in which the "interradial spaces have a hexagonal plate resting between the upper sloping side of the first radials."

The three species differ from all established genera of this family in having their arms constructed of single joints. It might, perhaps, be doubted whether this is a good generic character, as all Crinoids with double-jointed arms are single-jointed in their younger stages; but finding three species with the same kind of arms, and these comprising the only known Lower Silurian species of this family, we are evidently justified in making it a generic distinction.

Generic Diagnosis.—In general form closely resembling *Glyptocrinus.* Radials with a fold-like, strong, tubular ridge along their median line; interradial spaces depressed.

Underbasals five, well shown in a side view. Basals five, large; all of them hexagonal. Primary radials 3×5; the first ones heptagonal, but the upper sloping sides facing the azygous side longer, forming a deep notch for the reception of a very large anal plate. Secondary radials three or more, which have the appearance of arm-plates, and gradually pass into free joints. They have strong arm-like pinnules, given off from alternate sides.

Interradials consisting of one plate in the first row, two in the second, and three in the third row. The azygous side wider; the first plate extending far down between the first radials, sometimes touching the basals, and there are three in place of two plates in the second series. Structure of the ventral side unknown. Column small; cylindrical.

*1879. **Ptychocrinus angularis** (Miller and Dyer), **Glyptocr. angularis**, Journ. Cincin. Soc. Nat. Hist., p. 5, Pl. 1, fig. 10.—1883, **Gaurocr. angularis** S. A. Miller, Journ. Cincin. Soc Nat. Hist., vol. vi, p. 229.—Hudson River gr. Cincinnati, Ohio.

*1872. **Pt. parvus** (Hall), **Glyptocr. parvus**, Desc. New Crin., etc., Pl. 1, fig. 17 (without description), 24th Rep. N. Y. State Cab. Nat. Hist., p. 207, Pl. v, fig. 17, (?) Meek, 1873, Geol. Rep. Ohio, Pal. i, p. 36, Pl. 2, figs. 4 a b; (?)

S. A. Miller, 1883, Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 224.—Hudson gr. Cincinnati, Ohio.

Meek's description of this species, upon which the Cincinnati paleontologists have tried to identify it, is based upon specimens which did not show its characters, and therefore cannot be relied upon. Hall's figure exhibits a well-marked form, it shows plainly that it must have underbasals, and that a small anal plate extends down to the basals.

*1883. **Pt. splendens** (S. A. Miller), **Gaurocr. splendens**, Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 230.—Trenton gr. Cape Girardeau, Mo.

GLYPTASTER Hall, Rev. ii, p. 193.

Additional species:—

1881. *Gl. Egani* S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. iv (October), Pl. 6, figs. 4 a b.—Niagara gr. Chicago, Ill.

1882. *Gl. occidentalis* var. *crebescens* Hall. Eleventh Geol. Rep. Indiana, by Collett, p. 263.—Niagara gr. Waldron, Ind.

EUCRINUS Angelin, Rev. ii, p. 196.

DIMEROCRINUS Phillips, Rev. ii, p. 197.

Additional species:—

*1882. **D. waldronensis** (Miller and Dyer), **Cyathocrinus waldronensis**, Journ. Cincin. Soc. Nat. Hist., July (Abstr., p. 6), Pl. 4, fig. 9.—Niagara gr. (We have seen in the collection of Mr. Wm. Gurley, of Danville, a specimen which shows plainly the presence of dorsal interradials; and this feature, together with the double-jointed arm structure, proves, beyond doubt, that it is not a Cyathocrinoid).

LAMPTEROCRINUS Roemer, Rev. ii, p. 199.

Additional species:—

1879. (?) **L. parvus** Hall, Trans. Alb. Inst., vol. x (Abstr., p. 9).—Niagara gr. Waldron, Ind. (This may be a young specimen of **L. tennesseensis**. It apparently differs only in the much smaller size, and in having but four anal plates).

Family IV.—**MELOCRINIDÆ** Roemer.

(Emend. W. and Sp.).

a. Stelidiocrinites.

(?) **BRIAROCRINUS** Angl., Rev. ii, p. 96.

This is one of the genera in which we cannot trace satisfactorily the family relations, being in some of the characters allied to the Ichthyocrinidæ.

STELIDIOCRINUS Angl., Rev. ii, p. 98.

Additional species :—

*1883. (?) **Stelidiocrinus argutus** (Walcott), **Glyptocrinus argutus**, 35th Rep. N York State Cab. Nat Hist. (Adv. Sheet, p. 1), Pl. 17, fig. 9.—Trenton limest. Trenton Falls, N. Y. This is certainly not a **Glyptocrinus**. To judge from the figure, it is closely allied to **Stelidiocrinus**, but may be the type of a new genus.

PATELLIOCRINUS Angl., Rev. ii, p. 100.

MACROSTYLOCRINUS Hall, Rev. ii, p. 102.

Additional species :—

1882. **Macrostylocr. fusibrachiatus** Ringeberg, Journ. Cincin. Soc. Nat. Hist., vol. v, p. 119, Pl. 5, fig. 4.—Niagara gr. Lockport, N. Y.

1880. **M. striatus**, var. **granulosus** Hall, 28th Rep. N. Y. State Cab., p. 129; also 11th Geol. Rep. Ind., p. 258.—Niagara gr. Waldron, Ind.

CENTROCRINUS W. and Sp., Rev. ii, p. 104.

b. MELOCRINITES.

GLYPTOCRINUS Hall, Rev. ii, p. 135.

1883. S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. vi (December).
1883. W. and Sp. Amer. Journ. Sci. (April), p. 255.
1883. S. A. Miller. *Ibid.* (August), p. 105.
Not Etheridge and Nicholson, 1880, Silur. Foss. of Girvan Distr., p. 328.
Syn. *Pycnocrinus* S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. iv.

Since the absence of underbasals is clearly proved, *Glyptocrinus* differs from *Mariacrinus* only in the number of basals, which is five in place of four. Miller has founded the genus *Pycnocrinus* upon a species which he had previously referred to *Glyptocrinus*. Through the liberality of Mr. Miller, for which we are under lasting obligations to him, we have been given the freest access to his beautiful type specimens, with liberty to use them for our descriptions. We are reluctantly compelled to say that in our opinion *Pycnocrinus* is simply a young *Glyptocrinus*. The genus was founded principally upon the absence of "secondary radials," and the arms were said "to arise free from the primary radials." This statement does not agree with our observations, as we find in two of the specimens a minute interaxillary piece, and at least one secondary radial. In the two others, which are even more immature, the third primary radials, in part, take the functions of

the secondary radials, as seen by the surface ridges, which bifurcate along the middle portions of the plates. The plates succeeding them are still in a free state, and appear as arm-plates, but actually form extensions of the calyx, being not as yet connected by interradials and interaxillaries, as in the more adult specimens. A diversity in the number of secondary radials cannot be considered of generic value, at least not in a form like *Glyptocrinus*, in which, as Miller himself has shown us (Journ. Cincin. Soc., vol. vi, Pl. 11, fig. 1), the rays remain in an immature condition, more or less, even in the adult. The specimens referred to *Pycnocrinus* are so embryonic in their condition, that it would be speculation for us to assert to what species they belong, and we have concluded to leave them as doubtful species under *Glyptocrinus*.

The species now referred by us to *Glyptocrinus* have round columns, with the exception of *Glyptocrinus Fornshelli*, which Miller thinks may prove to be a distinct generic form; while those referred to *Reteocrinus*, with probably one exception, have pentagonal columns.

The species which were referred in Europe to *Glyptocrinus*, probably with the exception of *Glyptocrinus basalis* (?), belong to different genera. That species was figured without discription in Murchison's Siluria, p. 206, from a specimen with arms, and came from the Caradoc limestone. In this specimen, the plates of the calyx cannot be recognized, but the arms are those of *Glyptocrinus*. In the type specimen of McCoy, in which only the calyx is preserved, the interradials apparently touch the basals, which, if true, would exclude it from *Glyptocrinus*.

The specimens described by Nicholson and Etheridge, jun., under the name of *Glyptocr. globularis*, from the Craighead limestone and from Traive Glen. (Monogr. Silur. Foss. Girvan Distr. in Ayshire, 1880, pp. 328–30, Pl. 22, figs 9–11), probably belong to *Archæocrinus*. They evidently had underbasals, for the interradials rest upon the basals, and alternate with the first radial plates. Neither can the arms, fig. 12, on the same plate, which are composed of a double series of joints, be referred to *Glyptocrinus*.

We add the following species to our former list:

(?) 1854. **Glyptocrinus basalis** McCoy, Synops. Palaeoz. Foss., p. 57, plate I D, fig. 4, 1859, Murchison's Silur., p. 206.—Caradoc limest. Montgomeryshire, Great Britain.

1882. **G. miamiensis** S. A. Miller, Journ. Cincin. Soc. Nat. Hist., vol. 5, Pl. 1, fig. 1. Ibid., 1883, vol. vi, p. 224.—Hudson River gr. Waynesville, O.

1882. **G. sculptus** S. A. Miller, Journ., Cincin. Soc., vol. v, p. 13, Pl. 1, fig. 2, also Ibid., 1883, vol. vi, p. 234, Pl. 1, fig. 2.—Hudson River gr. Waynesville, O.

MARIACRINUS Hall, Rev. ii, p. 114.

Syn. *Compsocrinus* S. A. Miller, 1883, Journ. Cincin. Soc. Nat. Hist., vol. vi, p. 234.

Compsocrinus was described by Miller from a species which was said to possess a quadripartite base, supporting five radials and an anal plate; column quadrangular. Good specimens of "*Compsocrinus*" *Harrisi*, Miller's type, from the collection of Mr. Harris, who has the type specimens, show the number of basals to be four, as described by Miller; but the interradials at all sides rest upon the first radials, the posterior one not abutting against the basals as was asserted, and this makes *Compsocrinus* identical in structure with *Mariacrinus* as emended by us. If Miller's diagnosis had been correct, *Compsocrinus* would have been undoubtedly a good genus. Whether the column in other species of *Mariacrinus* is quadrangular, is not known.

*1881. **Mariacrinus Harrisi** (S. A. Miller), **Glyptocrinus Harrisi**, Journ. Cincin. Soc., vol. iv, Pl. 1, fig. 4.—**Compsocrinus Harrisi** Miller, Ibid., vol. vi, p. 234, Pl. 11, fig. 4.—Hudson River gr. Waynesville, O.

TECHNOCRINUS Hall, Rev. ii, p. 116.

MELOCRINUS Goldf., Rev. ii, p. 118.

1883. *M. Benedeni* (Dewalque MS.) Fraipont, Rech. sur les Crin. du Famenien de Belgique, Ann. de la Soc. géol. de Belg., Tome x, p. 60, Pl. 4, fig. 9.—Devon. superieur. Senzeille, Belgium.

1883. *M. Chapuisi* (Dewalque MS.) Fraipont, Ibid., p. 65, Pl. 5, figs. 5–7.—Devon. superieur. Senzeille, Belgium.

1882. *M. Clarkei* Williams, Proc. Acad. Nat. Sci. Phila., p. 31.—Genessee slate. Ontario Co., N. Y.

M. gerolsteinensis Steininger, 1853, Geogn. Beschreib. d. Eifel, p. 35, is not sufficiently defined for identification.

1883. *M. globosus* (Dewalque MS.) Fraipont, Rech. sur les Crin. du Famenien de Belg. Ann. Soc. géol. de Belg., Tome x, p. 61, Pl. 5, figs. 1–4.—Devon. superieur. Senzeille, Belgium.

1884. *M. inornatus* (Dewalque MS.) Fraipont, Ibid., Tome xi, p. 105, Pl. 1, fig. 1.—Devon. superieur. Frasne, Belgium.

1883. *M. Konincki* (Dewalque MS.) Fraipont, Ibid., p. 58, Pl. 4, figs. 6–8. Devon. superieur. Senzeille, Belgium.

1883. *M. mespiliformes* (Dewalque MS.) Fraipont, Ibid. p. 63, Pl. 5, figs. 8–10.—Devon. superieur. Senzeille, Belgium.

1882. *M. occidentalis* Oehlert, Bull. Soc. géol. de France (ser. 3), Tome x, p. 357, Pl. 8, fig 4.—Devon. inferieur. Near Sabré and La Flèche, France.

1883. *M. Oehlerti* W. and Sp. *Melocrinus Verneuili* Oehlert (not W. and Sp., 1881). Described Soc. géol. de France (Ser. 3), Tome x, p. 358, Pl. 8, fig. 5.—Devon. inferieur.—Sabré, France.

1884. *M. obscurus* (Dewalque MS.) Fraipont, Ibid., vol. xi, p. 107, Pl. 1, fig. 2.—Devon. superieur. Chaud fontaine, Belg.

SCYPHOCRINUS Zenker, Rev. ii, p. 123.

(?) **HADROCRINUS** Lyon, Rev. ii, p. 222.

DOLATOCRINUS Lyon, Rev. ii, p. 124.

1884. *D. triadactylus* Barris, Proceed. Davenport. Acad. Nat. Sci., vol. iv, Pl. 2, figs 5–7.—Hamilton gr. Alpena, Mich.

1871. *D. ornatus* Meek, Proc. Acad. Nat. Sci. Phila., p. 57.—Corniferous. Columbus, O.

STEREOCRINUS Barris, Rev. ii, p. 126.

Family V.—ACTINOCRINIDÆ Roemer.

a. Agaricocrinites.

CARPOCRINUS Müller, Rev. ii, p. 105.

Note.—In Rev. ii, p. 107, in place of *Carpocrinus elongatulus* read *C. elegantulus.*

(?) **LEPTOCRINUS** Angl., Icon. Crin. Suec., p. 3.

This genus was placed by Angelin under Platycrinidæ, but, if we understand the figure correctly, it is not only an Actinocrinoid, but even synonymous with *Carpocrinus*.

Additional species :—

1879. **Leptocrinus raridigitatus** Angl., Iconogr. Crin. Suec., p. 3, Pl. 20, figs. 18, 19, and Pl. 28, figs. 4, 4 a.—Upper Silurian. Gothland, Sweden.

DESMIDOCRINUS Angl., Rev. ii, p. 108.

AGARICOCRINUS Troost, Rev. ii, p. 109.

Additional species :—

1881. **A. crassus** Wetherby, Journ. Cincin. Soc. Nat. Hist., vol. v, p. 178, Pl. 5, fig. 1 a b.—Keokuk gr. Kentucky.

1881. **A. elegans** Wetherby, Journ. Cincin. Soc. Nat. Hist., vol. v, p. 179, Pl. 8, fig. 4 a b.—Keokuk gr. Kentucky.

ALLOPROSALLOCRINUS Lyon and Cass., Rev. ii, p. 118.

b. PERIECHOCRINITES.

PERIECHOCRINUS Austin, Rev. ii, p. 127.

S. A. Miller's late additions to this genus were made from natural casts, and there is the usual uncertainty as to their identification. We must consider them as doubtful species, until the external surface is known from casts or otherwise. Miller considers *Megistocrinus infelix* Winch. and Marcy, *Saccocrinus infelix* Miller, specifically distinct from *Saccocrinus Christyi* Hall, which Hall had doubted. He gives two more figures of the species, Journ. Cincin. Soc. Nat. Hist., vol. iv, Pl. 6, figs. 2 *a b*.

Additional species :—

*1881. **Periechocr. Egani ?** (S. A. Miller). **Saccocrinus Egani**, Journ. Cincin. Soc. Nat. Hist., Pl. 4, figs. 4, 4 a.—Niagara gr. Chicago, Ill.

*1865. **Periechocr. necis ?** (Winchel and Marcy). **Megistocrinus necis**, Memoirs Bost Soc. Nat. Hist., i, p. 111, Pl. 2, fig. 15. S. A. Miller, **Saccocrinus necis**, Journ. Cincin. Soc. Nat. Hist., 1881, Pl 4, figs. 3, 3 a.—Niagara gr Chicago, Ill.

*1882. **Periechocr. pyriformis ?** (S. A. Miller). **Saccocrinus pyriformis**, Journ. Cincin. Soc. Nat. Hist. (July), Pl. 3, figs. 3, 3 a.—Niagara gr. Chicago, Ill.

*1882. **Periechocr. urniformis ?** (S. A. Miller). **Saccocrinus urniformis**, Journ. Cincin. Soc. Nat. Hist. (July), Pl. 4, figs. 2, 2 a.—Niagara gr. Chicago, Ill.

ABACOCRINUS Angelin, Rev. ii, p. 133.

CORYMBOCRINUS Angelin.

1878. Angelin, Iconogr. Crin. Suec., p. 18.
1879. Zittel, Handb. d. Palæontologie I, p. 378.
Syn. *Eucalyptocrinus* McCoy, 1855 (not Goldfuss).
Syn. *Clonocrinus* Quenstedt, 1876 (not Oehlert, 1879).

The genus *Corymbocrinus* was in Pt. ii erroneously referred by us to the Calyptocrinidæ. It resembles *Eucalyptocrinus* so remarkably in the construction of the calyx plates, its deep basal concavity, and the perfect symmetry that prevails throughout the interradii, that we took it to be a connecting link between Actionocrinidæ and Calyptocrinidæ, but nearer the latter through *Callicrinus*, which we thought to be intermediate between *Corymbocrinus* and *Eucalyptocrinus*. To this view even the branching arms formed no serious objection, as Angelin has figured in the

Iconographia, Pl. 9, fig. 13, a malformed specimen of *Eucalyptocrinus*, in which some of the arms divide half-way up to the top, and in a similar manner, as in *Corymbocrinus*. Prof. Lindström, of Stockholm, however, informs us that the plates along the ventral side differ essentially in the two forms, and that the genus, in his opinion, could not be arranged with the Calyptocrinidæ. The total absence of special anal plates, unites it with the Melocrinidæ, and in this we agree with Zittel, but not with Angelin, who separated *Corymbocrinus* and *Abacocrinus* from *Melocrinus*, and placed them in separate families. The two genera have a similar arm-structure, but differ essentially in the construction of the calyx, the one having a strictly pentamerous, the other a decidedly bilateral symmetry. More close are the affinities with *Polypeltes*, provided we understand that genus correctly. We are somewhat in doubt whether Quenstedt's name *Clonocrinus*, should not be adopted in place of *Corymbocrinus*, as it probably has priority, but Quenstedt gives no generic description, only mentioning the name in connection with a certain species.

Generic Diagnosis.—Calyx basin, or low cup-shaped; basal portions broadly and deeply excavated; plates of very uniform size, rather heavy, somewhat convex, rarely ornamented; symmetry regularly equilateral, except in the basals.

Basals four, unequal, forming a hollow cone, which is filled by the upper portions of the column.

Primary radials 3×5, all wider than high. The first plate larger than the rest, its lower (here inner) side forming a part of the basal concavity, its opposite side at right angles with the column, only a small portion curved upward. The second radials quadrangular or nearly so, much wider than high, frequently with convex lower edges, narrower than the first radials. The third radials are pentagonal. Secondary radials $2 \times 2 \times 5$, comparatively large. Their upper series support two rows of transversely linear tertiary radials, arranged alternately like a double series of arm plates, but connected by interradial and interaxillary pieces, and hence forming parts of the body.

Arms long, bifurcating, gradually tapering to the distal ends; from their base up composed of a double series of very short but wide interlocking pieces. Pinnules long.

Interradials arranged longitudinally in rows of a single plate each. The first plate the largest in the calyx; ninesided; it ex-

tends from the upper sloping sides of the first primary radials to the first plate of the secondary radials. The second plate is much smaller, though yet comparatively large; it is hexagonal, and placed upon the first interradial and between the two secondary radials. There are two more interradial pieces above, which, like the two former, are longitudinally arranged. This arrangement is uniform in all five areas.

Interaxillary plates, one or two; the upper one cuneate, and inserted like the upper interradials between the tertiary radials. Construction of the plates of the ventral side unknown. The column is large, round, composed of low segments; articular faces provided with radiating striæ, except upon a small zone next to the periphery; central canal pentalobate.

Geological position, etc.—*Corymbocrinus* is only known from the Upper Silurian of England and Gothland.

Angelin refers to it the following species:

1840. **Corymbocr. corolliferus** Hisinger (**Cyathocr.** ?) **corolliferus**). Lethæa Suec. Suppl. sec., p. 6, Pl. 39, fig. 3, a-c. Angelin, 1878.—**Corymbocr. corolliferus**, Iconogr. Crin. Suec., p. 18, Pl. 23, fig. 19.—Upper Silurian. Gothland, Sweden.

1878. **Corymbocr. grandis** Angelin. Iconogr. Crin. Suec., p. 18, Pl. 9, figs. 2, 3.—Upper Silurian. Gothland, Sweden.

1878. **Corymbocr. grandistellatus** Angelin. Iconogr. Crin. Suec., p. 18, Pl. 9, fig. 4, and Pl. 23, figs. 18-21.—Upper Silurian. Gothland, Sweden.

1878. **Corymbocr. laevis** Angelin. Iconogr. Crin. Suec., p. 18, Pl. 23, fig. 20.—Upper Silurian. Gothland, Sweden.

1878. **Corymbocr. Panderi** Angelin. Iconogr. Crin. Suec., p. 18, Pl. 9, fig. 5, and Pl. 23, figs. 17, 17 a, b.—Upper Silurian. Gothland, Sweden.

1855. **Corymbocr. polydactylus** McCoy (**Eucalyptocr polydactylus**). Apud. Sedgewick, Synops. Pal. Foss., p. 58, Pl. 1 D, fig. 2; also Salter, 1873; Catal., p. 120; Angelin, 1878.—**Corymbocr. polydactylus**, Iconogr. Crin. Suec., p. 18, Pl. 9, figs. 1, 6-12, and Pl. 21, fig. 17.—Upper Silurian. Gothland, Sweden.

NOTE.—It is possible that *Mariacrinus macropetalus* Hall, Paleont. N. York, vol. iii, p. 111, Pl. 8 A, fig. 1, is a *Corymbocrinus*, but it may be a *Callicrinus* in place of *Mariacrinus*, as which it was described.

(?) **POLYPELTES** Angelin.

1878. Angelin, Iconogr. Crin. Suec., p. 27.
1879. Zittel, Handb. d. Paleont. i, p. 373.

The genus *Polypeltes* was described as being composed of "3 or more basals, 16 parabasals, 10 (?) × 1 radials (all axillary), numerous interradial and interaxillary pieces, and as having

10×12 primary arms." This formula was considered by Angelin and Zittel so distinct from that of any other known form, that both placed the genus in an independent family. We should follow their example, if we were satisfied as to the correctness of that description.

From the fact that Angelin gave the number of most of the above plates with doubt—he stated positively only the number of "parabasalia"—we infer that his specimens in the basal regions were not in a condition for critical examination. It is, moreover, apparent that an arrangement of plates, such as he described, is theoretically, as well as practically, impossible.

From the description it is difficult to ascertain which of the plates were intended as "basals" and which as "parabasals." In fig. 2, Pl. 9, of the Iconographia, there are represented close to the column two rings of plates; an upper or outer one, which is composed of 25 or 26 pieces, and close to the column an inner one, which, if any reliance can be placed in the figure (?), contains very nearly the same number, for the plates are represented as alternating with those of the upper ring. The former should contain the "parabasals," the latter the basals; but unfortunately the plates of both rings differ in number most conspicuously from the number attributed to "basals" and "parabasals" in the description.

Of all the plates to which the description alludes, the "ten (?) bifurcating radials" are most readily recognized, and we believe there are actually ten of these plates in the specimen. In the figure they occupy a position within the second ring, but along with other plates which are interposed between them. At the one side there is a small single piece, which we take to be an interaxillary plate; at the other are found two larger plates, evidently interradials, with possibly an additional anal piece at the posterior side. It is very probable that these 15 or 16 plates, which in groups of one, two, and three (?) are inserted laterally between the axillary radials, were taken in the description for "parabasalia," as otherwise those plates would be undescribed. If this is the case, the term has been incorrectly applied, as the name "parabasalia" has been given only to the ring of plates which lies beneath the radials, and between these and the underbasals. All plates which are laterally inserted between the radials, as in this case, are called interradials. It would be, however, equally incon-

sistent in principle to search for "parabasalia" among the plates of the first ring, for basals and "parabasals" are not placed beside each other, but the latter rest upon the ring of the former. We doubt if *Polypeltes* possessed any such plates as "parabasalia," at least not among the plates of these two rings. It is probable that the plates of the inner ring, like those of the outer, were partly radials and partly interradials, while the basals were hidden from view by the column. In support of this view it is well to compare the plates here exposed with those represented in allied genera.

According to description, the ten bifurcating radials are succeeded by two rows of from four to five plates, consisting of higher orders of radials; the upper series bifurcating, giving off another order of radials, and these the primary arms, which branch after becoming free. Comparing the different portions of the rays with the same parts in *Abacocrinus* and *Corymbocrinus*, we find the form of the radials, their proportionate size, and even the construction of the arms and their mode of branching, almost identical with those two forms, provided we compare the ten lower radials in *Polypeltes* with the ten rows of secondary radials in *Abacocrinus* and *Corymbocrinus*. The main difference is that the latter genus has but one bifurcation in the calyx above these plates, while the former has two, and consequently twice the number of primary arms, a difference only of specific value. From the fact that *Polypeltes* has an extra bifurcation, and twice as many primary arms as the other two genera, it might be asserted that it has exceptionally ten primary rays instead of five, and ten interradial spaces, but that is not the case. It has been stated that the ten radials are laterally disconnected, and separated on the one side by a single plate, and on the other by two larger pieces. The two larger ones are followed by numerous other plates, which, arranged in two rows, extend to the lower portions of the arms, and enclose these within the calyx, while the smaller plate at the other side stands perfectly isolated, surrounded on all sides by radials. That the former represent the plates of five interradial series, and the single piece an axillary plate, has been already stated, and this proves very clearly that *Polypeltes*, like other Crinoids, has but five main rays, that the ten axillary pieces in Angelin's figure represent $1 \times 5 \times 2$ secondary radials, and that the specimen must have somewhere primary radials.

Beneath the interaxillary plate, the figure indicates the presence of two plates, separated laterally, which, combined, have the form and position of a bifurcating plate. That there is a mistake in the figure with regard to these plates, seems to us beyond question. There is evidently but one plate in the specimen, and this represents a primary radial, while the two plates at each side of it, as in the succeeding ring, are interradials. The figures do not extend beyond this ring, all lower plates being evidently hidden from view by the large column, and hence the exact number of primary radials and basals is not known, but this was undoubtedly similar to that of allied genera, and not so abnormal as given by Angelin.

If it has three primary radials and four basals, which seems to us most probable, and at the same time a distinct anal interradius, we should not hesitate to place *Polypeltes* as a synonym under *Abacocrinus*, while under the same conditions, but with only three basals, it agrees with *Megistocrinus*. However, should it be proved that the posterior interradius has no additional plates, but is constructed like that of the four other sides, *Polypeltes* should be placed under *Corymbocrinus*. Only a variation in the number of primary radials, if our interpretation is correct, will warrant a generic separation, but in this case the name should be changed, as it becomes meaningless.

We suggest that in *Polypeltes* (?) the basals and the greater part of the primary radials form a deep concavity, which, to a large extent, is filled by the column, as in the case of *Corymbocrinus*, *Megistocrinus* and *Eucalyptocrinus*. We found a very similar case in *Megistocrinus concavus* Wachsmuth, from Alpena, Michigan, in which the basals and first radials form the lateral walls of a deep concavity, and are entirely hidden from view. The second radials are partly exposed, and form, with adjoining pieces, a ring of twelve very even, strongly nodose plates, which consist of five radials, four regular interradials, and three anal plates. Nobody would suspect one of these specimens to be a *Megistocrinus*, unless he obtained access to the deep funnel which contains the missing plates.

We deem it unnecessary to give a special diagnosis of *Polypeltes*, as we think it will eventually be placed under *Abacocrinus* or *Corymbocrinus*. It has the same long, branching arms, composed of two series of narrow interlocking pieces, and, as in that

genus, the lower portions of the arms are connected laterally for some distance by one or two rows of interbrachial pieces.

Angelin described under *Polypeltes* a single species :—

1878. (1) **Polypeltes granulatus** Angelin. Iconogr. Crin. Suec., p. 27, Pl. 24, figs. 2, 3.—Upper Silurian. Gothland, Sweden.

MEGISTOCRINUS Owen and Shum., Rev. ii, p. 135.

We compared *Megistocr. ontario* Hall, and *M. depressus* Hall, with good specimens in our own cabinet and in the Canada Survey Museum, and find the former to be a young example of *M. abnormis* Lyon, the latter of *M. rugosus* Lyon and Cass.

Additional species :—

1879. **M. pileatus** S. A. Miller. Journ. Cincin. Soc. Nat. Hist. (December), Pl. 16, figs. 1 a b.—Corniferous limest. Columbus, O.—This must be closely compared with **M. rugosus** Lyon and Cass., with which it may be identical.

1885. **M. concavus** Wachsmuth. Proceed. Davenport Acad. Sci., vol. iv, p. 96, Pl. 1, figs. 5–7.—Alpena, Mich.

*1836. **M. globosus** (Phill.) **Actinocr. globosus**, Geol. Yorkshire, p. 206, Pl. 4, figs. 26–29, also McCoy, 1844, Synops. Carb. Foss. Ireland, p. 182; W. and Spr. **Rhodocr. globosus**, Rev. ii, p. 212.—Mount. limest. England.

1885. **M. nodosus**, var. **multidecoratus** Barris. Proceed. Davenport Acad. Nat. Sci., vol. iv, p. 100.—Hamilton gr. Alpena, Mich.

c. ACTINOCRINITES.

ACTINOCRINUS Miller, Rev. ii, p. 138.

Phillipsocrinus caryocrinoides McCoy, Synops. Carb. Foss. Ireland, p. 183, Pl. 26, fig. 5, is evidently an abnormal specimen of *Actinocrinus pusillus* or some other closely allied species.

Actinocr. dalyanus S. A. Miller, 1881, is a synonym of *Actinocr. proboscidialis* Hall, and it is from the Lower Burlington limestone, not from the Keokuk limestone, as supposed by Miller.

A. tholus Hall. It is possible that the form which Hall described under this name, and which we took to be a synonym of *A. glans*, is more than a mere variety. We found lately in one and the same locality numerous specimens agreeing well with Hall's description, every one having convex or even slightly nodose plates; while those of *A. glans* are generally smooth or merely convex, and the form of the body is somewhat more elongate.

Additional species :—

1860. **A. spinotentaculus** Hall, Suppl. Geol. Rep. Iowa, I, p. 86.—Lower Burlington limest.—Burlington, Iowa.

TELEIOCRINUS W. & Sp., Rev. ii, p. 146.

In the second part of the Catalogue of Amer. Pal. Foss., p. 268, Miller calls *Teleiocrinus* "a subgenus of doubtful utility." The fact is we proposed it as a full genus of the Actinocrinites and not a subgenus of *Strotocrinus*. We stated expressly, *Teleiocrinus* holds the same relation to *Actinocrinus* as *Strotocrinus* to *Physetocrinus*, which, curiously enough, are both accepted by Miller. Probably all these genera are descendants of *Actinocrinus*, and it is difficult to see how Miller can reject *Teleiocrinus* when he accepts *Strotocrinus*.

STEGANOCRINUS M. & W.., Rev. ii, p. 149.

AMPHORACRINUS Austin, Rev. ii, p. 151.

PHYSETOCRINUS M. & W., Rev. ii, p. 155.

Additional species:—

*1881. **P. Copei** (S. A. Miller) **Actinocrinus Copei**, Jour. Cincin. Soc. Nat. Hist. (Decbr.), Pl. 7, figs. 2, 2 *a*.—This species, like all others which Miller described from New Mexico, came from the Lower Burlington limestone, and not from the Keokuk group.—Lake Valley, New Mexico.

STROTOCRINUS M. & W., Rev. ii, p. 158.

GENNÆOCRINUS W. & Sp., Rev. ii, p. 160.

d. BATOCRINITES.

BATOCRINUS Casseday, Rev. ii, p. 162.

Additional species:—

*1859. **B. grandis** (Lyon), **Actinocrinus grandis**, Amer. Journ. Sci., vol xxviii (September). p. 240.—Keokuk limest. Kentucky and Tennessee.—In the original description of this species, by mistake of the printer, the specific name was omitted. Lyon evidently intended to name the species **Act. grandis**, as that name is mentioned at the end of the description in discussing the geological position. We adopt this specific name, but place the species under **Batocrinus**. It has two arms extended from each arm base, a character only found among the Batocrinites.

ERETMOCRINUS Lyon & Cass., Rev. ii, p. 170.

Additional species:—

E. varsoviensis Worthen, 1882, Bull. i, Illinois State Mus. Nat. Hist., p. 30, and Geol. Rep. Ills., vol. vii, p. 306, Pl. 28, fig. 14. This species is synonymous with **E. originarius** W. & Sp.

DORYCRINUS Roemer, Rev. ii, p. 176.

Additional species :—

D. **lineatus** S. A. Miller, 1881, Journ. Cincin. Soc. Nat. Hist. (December), Pl. 7, figs. 3, 3 a, from New Mexico, is specifically identical with D. **unicornis** (O. & Shum.).

Family VI.—PLATYCRINIDÆ Roemer.

(Emend. W. & Sp.).

CULICOCRINUS Joh. Müller, Rev. ii, p. 61.

This genus is known only from casts, and reasonable doubts may be entertained as to the correctness of Müller's figures. That the whole ventral side had been covered by only five plates, as described by Müller, seemed to us not very probable, and we suggested in our description that perhaps it had been composed of eight pieces: a central plate, 6 proximals and an anal piece, of which the sutures had been obliterated. Of late, however, we are inclined to abandon this view, as the plates in question are too large to be proximals, neither can they be orals, for the larger plate is pierced by the anal opening. It seems to us *Culicocrinus* represents morphologically a still lower form than even *Coccocrinus*, that its ambulacra were subtegminal, and probably also the oral piece, unless this is represented by the tubercle in the larger plate.

COCCOCRINUS Joh. Müller. Rev. ii, p. 58.

(Revised).

In our generic description it was incorrectly stated that *Coccocrinus* had but a simple interradial to each side. This was partly due to a misunderstanding of the plates. The first range consists of three pieces, as clearly shown in *Coccocrinus bacca* Rœmer (Silur. Fauna West Tenn., Pl. 4, fig. 5 c). The middle plate, the one we described, rests within the notch of two first radials, the other two against the upper face of one of them, and against the second and third radials. A fourth plate, which we previously described as an oral plate, but which we regard now a secondary interradial, abuts against the upper faces of the three former. The plates of adjoining interradii do not touch laterally, but are separated by a very regular linear cleft, which extends all the way from the central gap to the arm furrows. There are nowhere

traces of ambulacra, which were probably hidden within the clefts, and partly covered by the interradials, instead of being placed, as we had supposed, on a level with them. A similar position was probably occupied by the central plate, which, in our opinion, formed the bottom part of the central space.

We have but little doubt that the conditions of *Coccocrinus rosaceus* were essentially the same as those of *C. bacca;* in the former, however, the outer interradials were not preserved, having been probably extended out to the free rays, as, more or less, in the case of all discoid species of *Platycrinus*. That they were present is indicated by the irregular width of the lateral clefts, which, as seen in the specimens, suddenly widen on approaching the arm bases, while they should rather grow narrower if representing the clefts between the orals in *Holopus*, as which they were regarded by Carpenter.

CORDYLOCRINUS Angelin, Rev. ii, p. 60.

MARSUPIOCRINUS Phillips, Rev. ii, p. 62.

Additional species:—

*1875. **M. præmaturus** (Hall), **Platycrinus præmaturus**, Geol. Rep. Ohio, Palæont. ii, p. 124, Pl. 6, figs. 3–6.—Niagara gr. Green Co., O.

PLATYCRINUS Miller, Rev. ii, p. 65.

Pl. discoideus Hall, 1858, not Owen and Shumard, 1850. = *Eucladocrinus pleuroviminus* White.

Additional species not noted before:—

1882. **P. monrœnsis** Worthen, Bull. i, Ill. State Mus. Nat. Hist., p. 30; also Geol. Rep. Ills. vii, p. 306, Pl. 30, fig. 9.—St. Louis limest. Monroe Co., Ill.—We have but little doubt that Prof. Worthen described here a young specimen of **P. bonœnsis** White.

1838. **Pl. coronatus** Goldfuss, Nova Acta, Leop. xix, i, p. 344, Pl. 31, fig. 8.—Carboniferous. Bristol, Engl.

Pl. bloomfieldensis S. A. Miller, syn. of **Platycrinus planus** O. and Shum.

Pl. poculum S. A. Miller. Too imperfect for identification.

Pl. vesiculus McCoy, Rev. ii, p. 76, read **Pl. vesiculosus**.

Pl. præmaturus Hall & Whitf. = **Marsupiocrinus præmaturus**.

EUCLADOCRINUS Meek, Rev. ii, p. 76.

COTYLEDONOCRINUS Cass and Lyon, Rev. ii, p. 77.

FAMILY VII.—HEXACRINIDÆ W. and Sp.

HEXACRINUS Austin, Rev. ii, p. 78.

Additional species:—

1884. **H. minor** (Dewalque MS.), Fraipont, Extrait des Ann. de la Soc. géol. de Belg., Tome xi, p. 110, Pl. 1, figs. 4 a and 4 b.—Devon. superieur Senzeille, Belgium.

1884. **H. verucosus** (Dewalque MS.), Fraipont, Ibid., p. 108, Pl. 1, fig. 3—Devon. superieur. Senzeille, Belgium

1882. **H. Wachsmuthi** Oehlert, Bull. géol de France (Ser. 3) Tome x. p. 355, Pl. 4, fig. 3.—Devon. inferieur. Sabré and La Fleche, France.

ARTHROACANTHA Williams.

1883. Williams, Proc. Am. Phil. Soc. (April), p. 84.
Syn. *Hystricrinus* Hinde, 1885, Ann. and Mag. Nat. Hist. (March), p. 158.

Prof. Williams proposed the name *Arthroacantha* in 1883, for a Crinoid of the *Hexacrinus* type with movable spines, of which he described and figured one species, *A. Ithacensis*, from the Chemung of New York. He also defined the characters of another species, from the Hamilton group, which had been named by Hall as *Platycrinus punctobrachiatus*, but not defined by him, except through the medium of a photograph privately distributed. To the latter species Williams gave the name *Arthroacantha punctobrachiata*.

In 1885, Dr. Hinde (Ann. and Mag. Nat. Hist., p. 158), proposed the name *Hystricrinus* for the genus defined by Williams, and described and figured a species, *H. Carpenteri*, from specimens derived from the Hamilton group of Ontario, Canada. He states that eminent authorities decided Williams' name to be invalid, by reason of its similarity to *Arthracanthus*, previously employed by Schmarda for a genus of Rotatoria. Examination of the question in the light of the Rules of the British Association, adopted in 1865, has led us to the conclusion that *Arthroacantha*, however injudiciously chosen to designate a genus of Crinoid, will have to stand. The tenth Rule (Am. Jour. Sci., July, 1869, p. 101) says: "A name should be changed which has before been proposed for some other genus in zoölogy or botany." It is evident from this that a proposed name may be ignored on account of identity with a prior name, but not by reason of mere similarity or resemblance

in form, however close. It is the word itself which determines its standing, and not its signification or derivation. The question is one of authority, and not of propriety or expediency, and it will be seen that the committee who reported the above-mentioned rule to the British Associaton, took the same view as to its effect that we do (Am. Journ., July, 1869, p. 107). *Arthroacantha* is a different word from *Arthracanthus*, although of the same etymology, and of similar construction, and there are other names of recognized standing in natural history, which bear a closer resemblance to prior names than this.

Another bibliographic question arises as to the species of this genus. Hall made a good figure of the type, which he called *Pl. punctobrachiatus*, but his plates were not published. Williams, however, when establishing the genus gave a brief but very clear definition of the characters of Hall's type specimen (Proc. Am. Phil. Soc., 1883, p. 83), and proposed for it the name *Arthroacantha punctobrachiata*. On p. 86 he again defined its principal characters by comparison with *A. ithacensis*. The "definition" necessary to impart authority to a published zoölogical term implies a "distinct exposition of essential characters." (See Committee's Report on Rule 12, Am. Journ., 1869, p. 102.) This was given by Williams far better than has been done in a great many specific descriptions of well known Crinoids. It is our opinion, therefore, that *A. punctobrachiata* is a good species, and that it must be credited to Williams. Whether Hinde's species is identical with *A. punctobrachiata* we cannot undertake to determine without more direct comparison of specimens. We have examined specimens from the Hamilton group of Ontario, Canada, which undoubtedly belong to *A. punctobrachiata*, and it is not improbable that *A. Carpenteri* may prove to be the same thing.

Arthroacantha is closely allied to *Hexacrinus*, from which it differs in having three primary radials instead of two, and movable spines along the surface of the plates. That the spines, which are frequently found in close proximity to the plates, are not mere broken parts of the plates, but constitute independent structures, is clearly seen from Prof. Williams' specimens, which he was good enough to send us for examination. The nature of the spines was disclosed to us more satisfactorily in specimens of *A. punctobrachiata* from the Hamilton of Canada, in which not only the calyx, but also portions of the arms were preserved, and in

which numerous detached spines lie upon the surface of the plates close to the tubercles from which they had been detached. That these spines, to some extent, were movable, is more than probable. They were evidently connected with the plates by elastic ligament, so as to yield when accidentally brought in contact with other objects, like the joints in a column, but we doubt if beyond this they represent, either functionally or structurally, the spines of the Echini.

These views differ somewhat from those held by Williams, who thinks it "not improbable that the original plates of *Lepidocentrus eifelianus*, described and figured by Johannes Müller, which were detached plates, associated with spines similar in nature to those just described and borne upon similar tubercles, were plates from the vault of a true Crinoid like *Arthroacantha*." And he remarks further, "we have here a possible clue to a relationship between true Crinoids and Perischœchinidæ.

There is in our opinion not the slightest doubt but that Müller's figures represent Echinoid plates, and that the spines which were found associated with them had the same functions as those of the true Urchins of later epochs; but we think that the spines of *Arthroacantha* form component parts of the plates taken separately, and as such we regard them as representing in a modified way the ordinary undivided spiniferous plates of other Crinoids. For this reason we cannot regard the movable spines of *Arthroacantha* of much more than of specific importance, but as the species also possess an additional primary radial, it may be well to separate them generically from species of *Hexacrinus* which do not have them. We allude to this more particularly, as Williams and also Hinde, was inclined to regard *Arthroacantha* as the type of a distinct family, a distinction, which, in our opinion, gives to the movability of the spines a degree of importance which it does from a morphological standpoint not deserve.

We also doubt if (?) *Arthroacantha Carpenteri* had whorls of cirrhi throughout the column, as supposed by Hinde. The columnar fragments which he figured on Pl. 4—if they belong to this species at all—evidently formed the lower portions of the stem, as shown by the size and the irregular arrangement of their branches, and as such are regarded by us merely as radicular cirrhi.

Generic Diagnosis.—In form and arrangement of plates closely

allied to *Hexacrinus*. All plates of the dorsal cup, the arm plates, and all interradial and summit plates, covered with numerous, irregularly arranged tubercles, provided centrally with a small pit for the reception of a long acicular spine.

Basals three, large, pentagonal. Primary radials 3×5; the lower one very large; the two upper ones small.

The anal plate has nearly form and size of the first radials, and occupies a similar position. The interradials are numerous and either cover the ambulacra completely, or open out to expose the covering plates. All plates of the calyx, dorsally and ventrally, except the basals, are provided with one or more movable spines, also the oral plate and proximals, but not the covering pieces, which, however, as stated, are not always exposed. Anus subcentral.

Arms two from each ray, simple or branching, and giving off slender pinnules from each joint. The proximal arm plates are composed of single cuneiform pieces, but these gradually interlock and turn into two series of alternate plates. Column round.

. *Geological position, etc.*—*Arthroacantha* has been found in the upper part of the Devonian, and of America only.

1883. **Arthroacantha ithacensis** Williams, Type of the genus. Amer. Philos. Soc., April, p. 83, with figures.—Hamilton gr. Near Ithaca, N. Y.

1882. **A. punctobrachiata** Williams, Trans. Amer. Phil. Soc. (April), pp. 83 and 86 (figured by Hall as **Platycrinus punctobrachiatus**).—Hamilton gr. Ontario, Can.

*1885. **A. Carpenteri** (?) Hinde (**Hystricrinus Carpenteri**), Ann. and Mag. Nat. Hist. (March), p. 162, Pl. 4.—Hamilton gr. Ancona, Ontario, Can. (Probably a *Syn.* of **Arthroacantha punctobrachiata** Williams.

DICHOCRINUS Münster, Rev. ii, p. 81.

Additional species:—

1860. **D. lachrymosus** Hall, Suppl. Geol. Rep. Iowa by Hall, p. 84.—Upper Burlington limest. Burlington, Iowa.—This species was erroneously referred by us to **Platycrinus**, and was said to be synonymous with **Pl. subspinulosus**, with which it agrees in the ornamentation of the plates. Fine specimens which we obtained lately, have convinced us that it is a **Dichocrinus**, and was correctly separated by Hall. It has a comparatively large number of interradial plates, a very conspicuous oral, and six large proximal plates. The anal aperture is lateral, somewhat protruding, placed at the upper edge of one of the first interradials, which is somewhat excavated. The radial dome plates are composed of small alternate pieces which we followed up to the second bifurcation of the ray. Arms given off from the third secondary radials, whence they branch once or twice again, always from the third plate.

D. cornutus Worthen, 1882, Bull. 1, Illinois State Mus., p. 35, and Geol. Rep. Ill., vol. vii, p. 313, Pl. 27, fig. 7, we take to be a mere synonym of **Dichocrinus ficus**.

1882. **D. hamiltonensis** Worthen, Bull. 1, Ill. State Mus. Nat. Hist., p. 35; also Geol. Rep. Ill., vol. vii, p. 312, Pl. 27, fig. 10.—Keokuk limest. Hamilton, Ill.

TALAROCRINUS W. & Sp., Rev. ii, p. 46.

Additional species:—

1882. **T. ovatus** Worthen, Bull. 1, Illinois State Mus. Nat. Hist., p. 28; also Geol. Rep. Ill., vii, p. 314, Pl. 19, fig. 11.—Kaskaskia gr. Monroe Co., Ill.

PTEROTOCRINUS Lyon & Cass., Rev. ii, p. 47.

FAMILY VIII.—ACROCRINIDÆ W. and Sp.

The Acrocrinidæ, so far as known, are represented by a single genus, and of this only three species have been described, two from the Chester (Kaskaskia) limestone, and one from the coal measures of America.

No attempt has ever been made to assign the genus *Acrocrinus* to its proper systematic position. Zittel and De Loriol in their classifications omit it entirely, and the descriptions by Yandell and Hall, which were from imperfect specimens, are indistinct and partly incorrect. Thanks to the kindness of Prof. Worthen, we have been able to examine a very perfect specimen of an undescribed species, which one of us described for volume vii of the Illinois Geological Report, and of which preliminary descriptions were published in Bulletin I, of the Illinois State Museum of Nat. Hist., p. 41. The specimen shows plainly that the base is bipartite, as Hall suspected, and not undivided, as stated by Yandell. Fortunately the other plates of the calyx were also in place, and in a condition to be critically examined.

Acrocrinus departs from most Palæocrinoidea in two important particulars, and upon these, mainly, the present family is founded. First: The plates of the calyx, which in all other species with large numbers of plates decrease in size from the basals to the arm bases, in *Acrocrinus* exhibit a decided increase in the same direction. Second: The radials are not connected with the basals, but separated from them by several rings of plates, which in position are partly radial, partly interradial, and which apparently are not represented in other genera of the Palæocrinoidea. This peculiar structure renders it exceedingly difficult in this

form to identify even those elements which are so readily recognized in other genera.

In *Acrocrinus Wortheni* Wachsmuth, the comparatively large basals are succeeded by a ring of twelve triangular plates, so minute, however, that it requires a magnifier to discover them. Another series of twelve larger plates constitutes the second ring. These plates are joined by their lateral edges, their lower angles resting between the preceding plates. Five of them have a radial direction, seven are placed interradially, one opposite each of the four regular interradial sides, three facing the anal side. Ten of the plates are hexagonal; only the middle one on the azygous side, and the plate which is directed to the anterior ray, are heptagonal. The two latter plates have truncate upper sides, which support, respectively, a vertical row of four very similar hexagonal pieces; one of them is interradial, and succeeded by anal plates, the other strictly radial.

The third ring consists of fourteen plates, larger than those of the preceding one. They are not so regularly arranged, and more variable in their size and form. Twelve of them alternate with the plates of the second ring, while the other two rest upon the truncate upper side of the heptagonal pieces just described. By this arrangement (see diagram, Pl. 9, fig. 1), the plate toward the anterior ray is the only plate in this ring which has a radial position, all others being located interradially, two to each of the four regular interradial sides, four to the azygous side.

The plates of the fourth ring differ considerably in form and size, and their whole arrangement is irregular throughout. They are sixteen in number, five radial in position, five directed to the anal side, one to each side adjoining the anterior ray, and two to each of the other two interradial sides.

Above the fourth ring, the plates are readily recognized as radials and interradials. In the specimen there are 2×5 radials, and the interradials consist of three to each of the four regular sides, and eight on the azygous side. The two radials connect with the radial plates of the fourth ring only in the anterior ray, in the four other rays they are separated from that ring by two interradial pieces, which join underneath.

In the original description of *Acrocrinus Wortheni*, the plates of the fourth ring were included with the radials and interradials, and the number of the former was given at three in the four

lateral rays, and four in the anterior ray, the number of interradials at six to seven, with eighteen anal pieces.

In this formula, the so-called first radials in four of the rays are laterally separated from the rest by intervening interradial pieces, a very uncommon but not altogether unprecedented occurrence among Palæocrinoids. In *Periechocrinus* the radials are not unfrequently found connected by their angles only, and sometimes, but exceptionally, one of them is altogether separated from the rest by intervening interradial plates. Such a feature, thus widely departing from the usual mode of occurrence, may in certain cases become a fixed and constant character, but it must not be overlooked, that by admitting the plates of this upper ring as radials, it becomes imperative to extend the term radials to every radial plate below, as each one of them is separated from the preceding plate in a like manner. This would increase the number of radials in *Acrocrinus Wortheni* to five (there was evidently a small bifurcating piece filling the concavity of the upper plate) in the lateral rays, and six in the anterior ray, a comparatively small number to what we must expect to find in *Acrocrinus Shumardi*, if we adopt the above interpretation for these plates.

Through the kindness of Prof. Whitfield, we recently had an opportunity to examine three specimens of the latter species from the Museum of Natural History of New York, which have afforded us additional information upon this interesting genus.

Acrocrinus Shumardi is much larger than *Acrocr. Wortheni*, and the calyx is composed of six to seven hundred pieces, while in the latter it has less than one hundred. There are two large basals; two contiguous radials, the lower one small, pentagonal, the other hexagonal with excavated upper side; three interradial pieces arranged as in the preceding species, the larger one resting between both radials of adjoining rays, the two lower ones abutting against the lower sloping sides of the second radials. The above radials and interradials are distinctly separated from the basals by a belt of small hexagonal pieces, which in position are partly radial, partly interradial. They are arranged alternately in rows, those of each successive series comparatively larger; but, while in *A. Wortheni* there are only four rings of from 12 to 14 pieces, Yandell's species has 14 to 20 rings, more or less, and 25 to 30 or more plates in each ring. Counting as before all plates

which are radial in position as radials, and all intermediate plates as interradials, the species possesses 12 and more radials to the ray, and 100 and more plates in each interradial space—an enormous increase over the plates in *Acrocr. Wortheni.* Such a wide difference in the number of interradial plates among species of the same genus is certainly very remarkable, but might be accounted for, as this class of plates is subject to great variation; but a numerical difference in the primary radials, if such was the case, would be exceptional. The primary radials are elements which, once developed, do not multiply, but their number is constant throughout the genus, and we doubt if *Acrocrinus* forms such a remarkable exception to the rule. It seems to us more probable that only the two large, contiguous upper plates, and the small triangular bifurcating piece succeeding them, are radials, that only the three intervening pieces in a lateral direction are true interradials, and that all lower plates, from the basals up, are merely accessory pieces, which obtained their position, whether radial or interradial, accidentally through their alternate arrangement, and the regularity with which they are distributed. By this interpretation the two species, which appeared to be so widely distinct, are brought within the limits of the same rule—both having the same number of radials, interradials and anal plates. It is true that accessory pieces like these are not found dorsally in any other genus of the Palæocrinoidea, but they are not uncommon among Cystideans, and similar plates occur ventrally in some of the larger Actinocrinidæ and Rhodocrinidæ, which, like those of the calyx, increase numerically by age, being represented sometimes by a single ring, and again, in the same species, by a wide belt of pieces. The accessory pieces in *Acrocrinus* increased in number by adding constantly new rings above the basals. This is well shown by the small specimen of *Acrocrinus Wortheni*, in which the plates of the latest ring are yet triangular, only the upper portion being developed; and it is further indicated by the increase in the size of the plates, which is in an upward direction.

In two of the New York specimens, the arms are partly preserved, and in the third one also portions of the vault. *Acrocrinus* had a third primary radial, which had not been observed in *Acrocrinus Wortheni.* It is triangular and resembles the small second radials of *Platycrinus*, resting like those within the con-

cavity of the larger plate. There are also secondary radials, but these extend into free rays.

ACROCRINUS Yandell.

1855. Yandell, Amer. Journ. Sci. and Arts, vol. xx (new ser.), p. 135.
1858. Hall, Geol. Rep. Iowa i, Pl. ii, p. 689.
1882. Wachsmuth, Bull. 1, Illinois St. Mus. Nat. Hist., p. 41.

Revised Generic Diagnosis.—Calyx goblet-cup or urn-shaped; composed of a large number of plates, which increase in size gradually from the basals up; plates thin and without ornamentation.

Basals two, comparatively large, either formed into a cup, or thickened at the lower side and extended into a rim; sometimes depressed and in form of a disk. The two plates are about equal, their suture running from the anterior to the posterior side; the upper side not excavated.

Primary radials 3 × 5, separated from the basals by a belt of numerous, small hexagonal pieces, arranged alternately in rows, those of each succeeding series comparatively larger. The first plate pentagonal, resting with the lower angles between the interradial plates of adjoining fields, the upper side supporting a second radial. Second radials hexagonal, more than twice as large as the first, especially much wider. They abut by their lower sloping sides against the upper interradials, and their lateral faces rest against corresponding plates of adjoining rays, except toward the posterior side, where an anal plate intervenes. Their upper sides are truncate and somewhat excavated. The third radials are axillary, very small, triangular, sometimes but partly occupying the concavity of the preceding plate. The higher orders of radials, so far as known, are extended into free rays as in *Platycrinus*. There are 2 × 2 × 5 secondary radials, which rest obliquely against the sloping sides of the triangular piece. They are short but wide; their inner sides connected by a suture, the outer side partly placed against a second primary radial, filling part of its concavity, and partly extended beyond it. In *Acrocr. Shumardi*, the outer pair of secondary radials gives off an arm; the inner division bifurcates again at the second plate, and supports 2 × 2 tertiary radials with an arm each, thus giving three arms to each main division, and six to the entire ray. The arm formula, however, may vary in other species.

Arms long, of nearly equal thickness throughout their length. They are composed of two series of very short pieces, alternately arranged. Ventral furrow wide and deep. Pinnules long, closely packed together, composed of six to seven joints, three times longer than wide.

Interradials three, in two series; the first series composed of two plates, which rest upon the belt of the supplementary intervening pieces already described, and between the sloping sides of the second radials. The second series consists of a single piece, placed between the upper sloping sides of the first radials, and the lower sloping sides of the second radials. The azygous side is known only in *A. Wortheni.* In that species it is composed of two hexagonal anal plates, resting upon a row of similar pieces, which, like those, are longitudinally arranged. The upper anal plate is placed in line with the second primary radials, and is higher, but not quite so wide; the second plate is somewhat smaller. At each side of the anal plates there are three interradials, which are formed and arranged like those of the four other sides.

The ventral covering is but imperfectly known; we only observed numerous thin, very minute, irregular pieces, with an elevation toward each ray. Position and form of the anus unknown.

Column round, somewhat tapering downward, composed of thin joints; central canal small.

Geological Position, etc.—*Acrocrinus* is the last and only surviving genus of the Camarata at the close of the subcarboniferous. It has been found only in the Mississippi valley, where it is exceedingly rare.

1855. **A. Shumardi** Yandell. Type of the genus, Amer. Journ. Sci. and Arts, vol. xx (new ser.), p. 135 with figure. (It was previously figured without description or name by Yandell and Shumard, 1847, in their Contrib. Geol. Kentucky, Pl. 1, fig. 3).—Chester or Kaskaskia limest. Grayson Co., Ky.

1858. **A. urnæformis** Hall. Geol. Rep. Iowa, i, Pl. ii, p. 690, Pl. 25, fig. 11 a, b.—Chester or Kaskaskia limest. Pope Co., Ill.

1882. **A. Wortheni** Wachsmuth. Bull. i, Ill. St. Mus. Nat. Hist., p. 41; also Geol. Rep. Ill., vii, p. 343, Pl. 30, fig. 13.—Coal measures. Peoria Co., Ill.

FAMILY IX.—BARRANDEOCRINIDÆ Angl.

BARRANDEOCRINUS Angl.

This is one of the most remarkable forms of the Palæocrinoidea. Looking at a perfect specimen with all its arms intact, it super-

ficially resembles a Blastoid. However, with the arms removed, it is found to possess all the essential characters of the Actinocrinidæ, and doubts might be entertained whether it should not be grouped with that family. Angelin and Zittel have made it the type of a distinct family, and we think the peculiar construction of the arms and ventral side fully justifies this separation. The arms of *Barrandeocrinus*, if we correctly understand the figures, were permanently in a recumbent state or moved with great difficulty; they were laterally connected at the tips of their pinnules, at least those of the same ray, and could not be closed in the usual way.

Generic Diagnosis.—In its general outline, with the arms attached, resembling a Blastoid; form globose; calyx, without arms, cup-shaped. Arms arranged in pairs; recumbent; their dorsal side directed toward the calyx, the ventral side exposed to view. They are united laterally by the tips of their pinnules so as to completely cover the calyx, and extend beyond it to the upper part of the column, which is somewhat indented for their reception.

Basals three, equal. Primary radials (?) 3×5,[1] the first considerably larger. The axillary radials support at each upper side a single rather large secondary radial, and these support an arm each. Interradials arranged as in the Actinocrinidæ; the four regular sides, up to the arms, consisting of only one plate, which rests upon the first radials. The axygous side has two large anal plates; the lower one meeting the basals, the other placed between the interradial which is bisected for its reception. These are succeeded by three much smaller and elongate interradial plates, and a similar number of interaxillary pieces of exactly the same form and arrangement as the three interradial ones. Ventral surface deeply depressed along interradial and interaxillary spaces, the depressions which grow deeper toward the equatorial zone alternating with ten flattened ridges which led to the ten arms.

Arms heavy; composed of a single row of closely set, quad-

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[1]Angelin states that the number of radials is 2×5, while Zittel gives it as 3×5. In Angelin's figure, Icon. Suec., Pl. v, figs. 6, 6 a, there appear to be but two primary radials, the second plate being axillary. But in the specimens represented on Pl. iv., fig. 5 a, and Pl. xxii, fig. 3, three of them are visible, arranged as those of *Actinocrinus*. It is probable that the true number is three, and that in the first mentioned specimen the sutures between the second and third radials became obliterated by anchylosis.

rangular plates, with strong, apparently immovable pinnules, laterally connected. The arms are so closely folded together that they appear as if they were suturally connected, and formed around the calyx a solid body with ten ambulacra upon the surface.

Column stout, circular, with pentangular axial canal.

The only known species is:

1878. **Barrandeocrinus sceptrum** Angl. Icono. Crin. Suec., p. 8, Pl. 4, figs. 5, 5 a, and Pl. 5, figs. 6, 6 a, and Pl. 22, figs. 2–4.—Upper Silur. Gothland, Sweden.

FAMILY X.—CALYPTOCRINIDÆ Roemer.

Roemer, in proposing this family, used the name Eucalyptocrinidæ (Leth. Geogn., Aug. 3, 1855, p. 229), which was afterwards changed by Angelin to Calyptocrinidæ (Icon. Crin. Suec., 1879, p. 14). The latter name was accepted by Zittel, who referred to it also Lyriocrinus Hall, which we have placed under the Rhodocrinidæ.

EUCALYPTOCRINUS Goldfuss.

(HYPANTHOCRINUS Phillips.)

1826. Goldfuss. Petref. Germ., i, p. 212.
1835. Agassiz. Mem. Soc. des Sci. natur. de Neuchatel, i, p. 197.
1838. Goldfuss. Nova Acta. Leopold., xix, i, p. 335.
1841. Müller. Berl. Acad. d. Wissensch., p. 210.
1841. Hall. Paleont. N. York, ii, p. 207.
1843. Roemer. Rhein. Nebergangsgeb., p. 64.
1850. D'Orbigny. Prodr. de Paléont., i, p. 45.
1852. Quenstedt. Handb. der. Petrefactenk., p. 624.
1854. McCoy (in part). Synops. Brit. Palæoz. Fossils, p. 57.
1855. F. Roemer. Lethæa Geogn. (Ausg. 3), p. 257.
1857. Pictét. Traité de Paléont., iv, p. 307.
1860. Bronn. Klassen des Thierreichs (Actinozoa), Pl. 27.
1862. Hall. Notice of New Foss. from Waldron, p. 3.
1862. Dujardin and Dupé. Hist. natur. des Zooph. Echin., p. 115.
1865. Hall. 15th Rep. N. Y. State Cab. Nat. Hist. p. 32.
1866. Schultze. Monogr. Echin. Eifl. Kalk., p. 90.
1878. Angelin. Iconogr. Crinoid. Suec., p. 16.
1879. Hall. 28th Rep. N. Y. State Cab. Nat. Hist. (edit. ii), Pls. 16–19.
1879. Wetherby. Journ. Cincin. Soc. Nat. Hist. (April), No. 5.
1879. Zittel. Handb. der Paleont., i, p. 379.
1882. S. A. Miller. Journ. Cincin. Soc. Nat. Hist. (July).

(?) Syn. *Hypanthocrinus* Phill., 1839; Murchison's Silur. System, p. 672, Pl. 17, fig. 3; Zittel, 1879; Angelin, 1878; S. A. Miller, 1880.

There is some doubt whether *Hypanthocrinus* Phillips i synonym of *Eucalyptocrinus* or a good genus. *Hypanthocri* was separated by Phillips simply upon the presence of a colu which Goldfuss thought to be absent in *Eucalyptocrinus*, but *E. rosaceus*, his type is known to be pedunculated, this disti tion fails. Angelin and Zittel, who both uphold *Hypanthocri* describe the base as being less deeply funnel-shaped, the a tube as extending beyond the arms, and the partition walls rounding the arms as being constructed principally of a sin piece. A critical comparison has convinced us that these cha ters are not constant throughout the species. The only charac upon which a separation might possibly be effected, is the p boscis-like anal tube, but this part, unfortunately, is rarely p served. Some of the American species with a long tube hav deep, funnel-shaped base, while in others with a simple openi the base is comparatively shallow. In all of them the partit walls between the arms consist of two pieces, but in some spe the lower one is comparatively longer than in others. We sl ignore *Hypanthocrinus* until better distinctions are given.

Eucalyptocrinus is closely allied to *Callicrinus*, from whic differs in having rudimentary partitions between the arms, tending out only a short distance, leaving the greater part of arms free and unprotected.

Among the species that have been referred to *Eucalyptocri* are several which were described from natural casts. We do deny that their generic relations were correctly identified, that differences of specific value probably exist among them. we doubt if it is possible for any one to decide from inter casts whether such specimens are specifically distinct from oth in which the test is preserved, and hence consider them for present as doubtful species.

Troost's *Eucalyptocrinus conicus*, *E. extensus*, *E. gibbosus*, *Goldfussi*, *E. lævis*, *E. Nashvillæ*, *E. Phillipsii* and *E. Tenn seæ*, all from the Niagara of Western Tennessee, are mere ca logue names, no descriptions having been published

Generic Diagnosis. When the arms are attached more or l ovoid, without arms resembling a wine bottle with concave b tom and long slender neck. The neck is surrounded by ten p titions, arranged vertically so as to form ten niches or compa ments for the reception of the arms. The calyx is composed

heavy plates, is either cup- or saucer-shaped, with basal regions deeply concave, somewhat funnel-shaped. In the dorsal cup the pentamerous symmetry is interrupted by the basals only; at the ventral side, however, it is greatly disturbed. Anus central, located at the top of the neck-like prolongation, or at the end of a tube.

Basals four, small, unequal in size, one of them larger than the rest; axial canal five-rayed; its radii directed interradially, there being two of them in the larger plate. As a rule the basals are not seen externally, being placed at the upper end of the concavity, which also involves the greater part of the first radials, and frequently other plates.

Radials in three orders, the tertiary radials, however, imperfectly developed, and taking rather the form of brachials. Primary radials 3×5; the first one large, wider than the other two; the second quadrangular, wider than high; the third hexagonal, its upper side truncate for the reception of an interaxillary plate. Secondary radials $2 \times 2 \times 5$, all pentangular, the lower series larger than the upper, those of the same division connected by horizontal suture. The upper secondary radial is axillary, and supports the tertiary radials, which are composed of two short transverse pieces supporting the arms.

Dorsal interradials three to each interradius, throughout the genus, in young as well as in adult specimens. The lower one is the largest plate in the calyx, and always decagonal. The two upper plates are connected by a vertical suture to their full length, and both combined are smaller than the lower one. Their upper ends form a narrow quadrangular projection, which extends to the top of the tertiary radials, and supports upon its truncate upper side the interradial partition walls. The interaxillary plates of the dorsal side consist of a single piece in each ray, placed between the secondary radials. In form and dimensions it resembles most remarkably the two upper interradial plates, its upper end projecting in a similar manner to the top of the tertiary radials, and also supporting a partition. The peculiar projections between the arm sockets give to the specimen a very marked appearance, and when the ventral side is not preserved, form a reliable guide for generic identification.

The ventral side consists of four rings of plates. The lower ring is composed of five elongate interradials, which rest upon

the projecting faces of the interradials at the dorsal side. There are five interaxillary plates of a similar form, supported by the dorsal interaxillaries, and ten small triangular interbrachial pieces, interposed in such a manner between the foregoing plates that always an interradial and an interaxillary meet laterally above an interbrachial. The second and third rings consist of four plates each; the fourth of ten. The two former ones together form the neck-like prolongation of the body, and the plates of the fourth ring, combined with those of the first ring, the partition walls encasing the arms.

The interradials and interaxillaries of the first ring are uniform in size and shape; they are knife-like, their blunt sides exposed to view, their sharp edges turned inward. Toward the lower end where the plates decrease in depth, lateral flanges project out from their inner edges, which unite suturally, and enclose the visceral cavity, while the knife-like outer portions, as we understand it, are merely extraordinary protuberances, like the nodes or spines in some Actinocrinidæ, but forming by means of their connected wing-like extensions a cover or protection for the arms.

The plates of the second ring fit into the ten angles formed by the preceding plates, but do not alternate with them. Two of them are a little wider, and these are alternately arranged with the smaller ones. The two narrower plates are generally longer, angular above, while the two others are truncate, and their lateral faces slightly sloping upward. When united, they form a funnel with the narrow opening upward. Transversely they form a ring with ten protuberances, which on their outer surface represent longitudinal ridges. The ridges correspond in position with the interradial and interaxillary partition walls which overlap them, while the alternate grooves form the inner angle of the niches.

The third ring, like the second, consists of four plates, but these, as a rule, are not so large, and have a more irregular arrangement; two of them are generally shorter, and do not touch those of the preceding ring. They are provided at their outer faces with ten longitudinal ridges, which, to their full length, are overlapped by the partition walls, which extend downward from the fourth ring of plates.

The plates of the fourth ring are constructed upon a similar plan as those of the first ring. Like those, they consist of ten

pieces, but they undergo more variations among species, and show more irregularities than any of the other plates. In some species they are confined almost exclusively to the upper face, being mere top pieces; in others they represent an important part in the partition walls, while in still others they extend deeply down into the tubular neck, forming the upper part of its walls. In all cases, however, their obtuse edges are turned outward, and form the upper part of the partition, being suturally connected with the lower part of them.

The plates covering the tubular neck, *i. e.*, anal plates, consist of small pieces, with a somewhat subcentral opening, or, as in *Eucalyptocrinus rigens* Angelin, of valvular plates. Sometimes they are extended into a free tube, composed of hexagonal pieces. The arrangement of the plates surrounding the anal opening is more regular than it appears from some specimens. The apparent irregularities are caused largely by the plates of the third ring, which, in some species, have their upper ends partly exposed.

The arms are arranged in pairs, each pair filling one of the ten compartments, with an interradial partition wall on one side, and an interaxillary one on the other. The arms evidently moved with difficulty, being heavy, and in the adult composed of two rows of short transverse pieces, with horizontal sutures, but there was a single row of wedge-shaped pieces in young specimens. They have a deep ventral furrow, and long pinnules composed of numerous joints, which gradually decrease in width. The arms and pinnules are so closely fitted into the partition walls, that when the arms are perfectly closed, it appears as if they were suturally connected and constituted a part of the body.

The visceral cavity actually is formed only by the plates of the dorsal cup and by the two lower rings of plates in the vault, the plates of the two upper ones forming the neck-like prolongation. The food grooves enter the calyx at the base of the arms, and proceed within shallow grooves at the inner floor to near the top of the second ring. The hydrospires evidently extended to the lower portion of the neck, and perhaps (?) communicated with the exterior through the anal aperture, as apparently no other opening except the ambulacral passages enter the body.

The column is moderately large, cylindrical, composed of rather long joints, with pentapetalous central canal. It evidently had no lateral cirrhi, except at the root, where it gives off hundreds of

little rootlets, which gradually taper, spreading out horizontally.

Eucalyptocrinus is one of the most perplexing genera, especially by reason of its peculiar ventral structure. The only ventral plates about which there seems to be no doubt are those of the first ring, which have been designated by all writers as large interradials and interaxillaries, *i. e.*, interdistichalia. More dubious are those of the second ring, which partly cover the peristome. They fit with their projecting angles into the ten re-entering angles formed by the sloping sides of the preceding plates. The plates of the one ring practically alternate with those of the other, for by bisecting the two smaller plates, and dividing the larger ones into three pieces, we obtain ten nearly equal plates, alternately arranged, thus proving that the plates are not in part interaxillaries; but what are they? We doubt if they are calyx interradials; the fact that there are four plates is certainly a very serious objection. By dividing the plates among the five interradii, some of the pieces would be distributed among different areas. Another interpretation seems to us more probable, and offers at the same time an explanation of the plates in the third ring.

The proximals and the oral plate, in all Palæocrinoids with nearly central anal tube, are pushed to the anterior side, and the oral plate and the two smaller proximals constitute actually a part of the tube of which the four larger proximals form the base. We think the case is very similar in *Eucalyptocrinus*, but here, owing to the strictly central position of the anal tube, not only one of the proximals, but also the oral plate is penetrated by the anal passage, and divided into two parts. This, if correct, suggests that in *Eucalyptocrinus* the four plates of the second ring represent the four large proximals, a view which seems to be confirmed by the peculiar arrangement of the plates in the third ring, in which we consider that the two smaller ones represent the two smaller proximals, while the two larger pieces, which rest upon all plates of the second ring, are equivalent to the oral plate. This would further suggest, that the ten plates in the fourth ring are extravagantly developed anal plates.

Geological position, etc.—*Eucalyptocrinus* is one of the leading genera of the Upper Silurian, and it occurs in America and Europe. A single species is known from the Devonian.

The following species have been described :—

(?) 1865. **Eucalyptocr. chicagoensis** Winch. & Marcy. Mem. Bost. Soc. Nat. Hist., vol. i, No. 1, p. 90.—Niagara gr., Chicago, Ill. (Described from casts.)

1843. **E. cœlatus** Hall (**Hypanthocrinus cœlatus**). Geol. 4th Distr. N. Y., p. 113, fig. 1.—F. Roemer, 1855, Leth. Geogn. (Aug. 3), p. 260. **E. cœlatus** 1852, Hall, Palæont., N. Y., p. 210, Pl. 47, figs. 4 *a–e*; F. Roemer, 1868, Silur. Fauna West. Tenn., p. 48, Pl. 4, fig. 3; Hall, 1865, Trans. Alb. Inst. (Abstr., p. 32); also 20th Rep. N. Y. State Cab. Nat. Hist., pp. 321–329 (Revised Edit., pp. 363–366); 28th Rep. N. Y. State Cab. Nat. Hist., p. 142, Pl. 16, figs. 1–10, and Pl. 19, figs. 1–3: also 11th Ann. Geol. Rep. Indiana, p. 274, with plates.—Niagara gr. Lockport, N. Y.

(?) 1864. **E. cornutus** Hall. New or little known Foss. Niagara gr., p. 18; also 1865, 18th Rep. N. Y. State Cab. Nat. Hist., p. 322, Pl. 11, figs. 8–10.—Niagara gr. Waukesha and Racine, Wisc. (Described from casts.)

Var. excavatus Hall, 1864. New or little known Foss. Niagr. gr., p. 18; also 18th Rep. N. Y. State Cab. Nat. Hist., p. 322, Pl. 11, figs. 8–10.—Niagara gr. Racine, Wisc.

1879. **E. constrictus** Hall. Trans. Alb. Inst., vol. x (Abstr., p. 10); also 11th Ann. Geol. Rep. Indiana, p. 273, Pl. 15, fig. 1.—Niagara gr. Waldron, Ind.

1863. **E. crassus** Hall. Trans. Alb. Inst., vol. iv, p. 197; 18th Rep. N. Y. State Cab. Nat. Hist., p. 323, Pl. 11, figs. 2, 3 (Revised Edit., p. 365); also 28th Rep. N. Y. State Cab. Nat. Hist., p. 141, and Pl. 17, figs. 1–11, and Pl. 18, figs. 1–9: also Pl. 19, figs. 2, 4, 5; Eleventh Ann. Rep. Indiana, 1851, p. 27, Pl. 17, figs. 1–11, and Pl. 18, figs. 1–9; Geol. Surv. Ohio, Paleont., ii, p. 129, Pl. 6, fig. 11 (Green Co., O.).—Niagara gr. Waldron, Ind.

1839. **E. decorus** Phill. (**Hypanthocr. decorus**) Murch. Silur. Syst. p. 672, Pl. 17, fig. 3; also Hall, 1843, Geol. 4th Dist. N. Y., p. 113, figs. 2–3. **Eucalyptocr. decorus** Hall, 1852, Paleont. N. Y., vol. ii, p. 207, Pl. 47, figs. 1–3; and Pl. 85, fig. 7; also McCoy, Synops. Brit. Palæoz. Foss, p. 58; also F. Roemer Leth. Geogn., 1855 (Aug. 3, p. 259); Dujardin and Hupé, 1862, Hist. natur. des Zooph. Echinod., p. 116.—Rochester and Lockport, N. Y., and Dudley, Engl. (?)

1878. **E. decoratus** Angelin. Iconogr. Crin. Suec., p. 17, Pl. 5, figs. 4, 4 a.—Upper Silurian. Gothland, Sweden.

(?) 1880. **E. depressus** S. A. Miller. Journ. Cincin. Soc. Nat. Hist. (October), Pl. 7, figs. 1, 1 a.—Niagara gr. Chicago, Ill. (Described from a cast.)

(?) 1880. **E. Egani** S. A. Miller. Journ. Cincin. Soc. Nat. Hist., vol. iii, Pl. 4, fig. 1. —Niagara gr. Chicago, Ill. (Described from casts.)

1878. **E. excellentissimus** Angelin. Iconogr. Crin. Suec., p. 16, Pl. 24, fig. 15.—Upper Silurian. Gothland, Sweden.

1847. **E. granulatus** (Lewis) Morris (**Hypanthocr. granulatus**). London Geol. Journ., Part 3, p. 99, Pl. 21, figs. 1–5; also Angelin, Iconogr. Crin. Suec., 1878, p. 18, Pl. 6, figs. 3, 4; also Pl. 24, figs. 10–12; and Pl. 29, figs. 69, 70–74.—Upper Silurian. Walsall, Engl., and Gothland, Sweden.

1875. **E. magnus** Worthen. Geol. Rep. Illinois, vol. vi, p. 501, Pl. 25, fig. 3.—Niagara gr. Wayne Co., Tenn.

*1878. **E. minor** Angelin (**Hypanthocr. minor**). Iconogr. Crin. Suec., p. 17, Pl. 6, fig. 1: also pl. 24, figs. 9–13.—Upper Silurian. Gothland, Sweden.

(?) 1864. **E. obconicus** Hall. New or little known Foss. Niagr. gr., p. 19; also 1865, 18th Rep. N. Y. State Cab. Nat. Hist., p. 323, Pl. 11, fig. 1.—Niagara gr. Racine, Wisc. (Described from internal casts.)

(?) 1861. **E. ornatus** Hall. Rep. of Progress of Geol. Surv. Wisc., p. 20.—Niagara gr. Racine, Wisc. (Described from internal casts.)

1850. **E. ovalis** Troost. Proc. A. A. A. Sci., p. 60; Hall, 1876 (**E. ovatus** Hall. Not Angelin, was printed in place of **E. ovalis.**) Dec. Edit., 1876, p. 143, Pl. 17, figs. 12, 13; also 11th Ann. Geol. Rep. Indiana, with plates.—Niagara gr. Waldron, Ind.

1878. **E. ovatus** Angelin. Iconogr. Crin. Suec., p. 17, Pl. 5, figs. 1, 2.—Upper Silurian. Gothland, Sweden.

1852. **E. papulosus** Hall. Paleont. Rep. N. York, vol. ii, p. 211, Pl. 47, figs. 5 a, b; also F. Roemer, Leth. Geogn., 1855 (Aug. 3, p. 260).—Niagara gr. Monroe Co., N. Y.

1878. **E. plebejus** Angelin. Iconogr. Crin. Suec., p. 17, Pl. 5, fig. 7.—Upper Silurian. Gothland, Sweden.

(?) 1882. **E. proboscidalis** S. A. Miller. Cincin. Jour. Nat. Hist. (December), p. 224.—Niagara gr. Pontiac, O. (Described from internal casts.)

1860. **E. ramifer** Roemer. Silur. Fauna West Tenn., p. 51., Pl. 4, fig. 4.—Niagara gr. Decatur Co., Tenn.

*1837. **E. regularis** (Hisinger), **Actinocr. regularis.** Lethaea Suec. (Suppl. 2), p. 6, Pl. 39, fig. 6.—**Hypanthocr. regularis** Angelin, 1878, Iconogr. Crin. Suec., p. 17, Pl. 6, fig. 2, and Pl. 24, figs. 11–20, and Pl. 29, figs. 3a–6a. Upper Silurian. Gothland, Sweden.

1878. **E. rigens** Angelin. Iconogr. Crin. Suec., p. 17, Pl. 9, fig. 13, and Pl. 24, figs. 16–19, 21; and Pl. 29, figs. 30, 31.—Upper Silurian. Gothland, Sweden.

1826. **E. rosaceus** Goldf. (Type of the genus.) Petref. German. i, p. 214, Pl. 64, fig. 7; also Nov. Acta Leop. xix, p. 385, Pl. 30, fig. 6. Agassiz, 1836, Mem. des Sci. natur. de Neuchat. i, p. 197; also F. Roemer, Rhein. Uebergangsgeb., p. 64. De Koninck and Lehon, Crinoid. Carb. Belg., p. 73; also Roemer, Leth. Geogn., 1855 (Aug. 3), p. 259, Pl. 4, figs. 20 a–c, and Pl. 4, figs. 11 a–c. Dujardin and Dupé, 1862, Hist. natur. des. Zooph. Echinod., p. 116; Bronn, Klassen d. Thierreichs (Actinozoa), Pl. 27, fig. 2; Pictét, 1857, Traité de Paléont. iv, Pl. c, fig. 1; Schultze, 1866, Monogr. Echin. Eifler Kalk., p. 90, Pl. 11, figs. 1–14.—Lower Devonian. Eifel, Germany.

(?) 1882. **E. rotundus** S. A. Miller. Cincin. Journ. Nat. Hist., vol. v (July), Pl. 3, fig. 4.—Niagara gr. Chicago, Ill. (Described from casts.)

1878. **E. speciosus** Angelin, Iconogr. Crin. Suec., p. 16, Pl. 5, fig. 8, and Pl. 29, figs. 27–29 and 32–34.—Upper Silur. Gothland, Sweden.

1877. **E. splendidus** (Troost) Hall, Geol. Surv. Ohio, Paleont. ii, p. 128, Pl. 6, fig. 12. Niagara gr. Springfield, O.

(?) 1878. **E. tuberculatus** Miller and Dyer, Journ. Cincin. Soc. Nat. Hist. (April), Pl. 2, figs. 9, 9 a.—Niagara gr. Waldron, Ind.—Evidently a mere variety of **E. coelatus** Hall.

(?) 1882. **E. turbinatus** S. A. Miller, Cincin. Journ. Nat. Hist., vol. v (July), Pl. 3, fig. 5.—Niagara gr. Chicago, Ill.—Described from internal casts.

NOTE.—*Eucalyptocrinus polydactylus* McCoy, is a *Corymbocrinus*, and *E. armosus* McChesney is too imperfectly known for identification.

CALLICRINUS D'Orbigny.

1850. D'Orbigny (*Calliocrinus*), Prodr. i, p. 45.
1878. Angelin (*Callicrinus*), Iconogr. Crin. Suec., p. 14.
1879. Zittel (*Callicrinus*), Handb. d. Paleont. i, p. 378.
Syn. *Eugeniacrinites* Hisinger (not Miller), 1857, Leth. Suec., p. 86.

Callicrinus (*Calliocrinus* d'Orbigny) may be considered as a transition form between *Corymbocrinus* of the Actinocrinidæ and *Eucalyptocrinus*. It possesses the structural peculiarities of the latter, but these are not so distinctly expressed, and it appears as if the genus represented an earlier phase in the development of this family. In both genera, the dorsal and ventral side is composed of plates of a similar kind and like number, and both have partitions ventrally; but, while those of *Eucalyptocrinus* surround the arms on all sides, the partitions of *Callicrinus* are rudimentary, the greater part of the arms being uninclosed.

Generic Diagnosis.—Calyx as in *Eucalyptocrinus*, extending to the tips of arms, resembling a wine bottle with long, slender neck, and deep concavity at the bottom, but the partition walls, in place of forming deep niches, consist only of braces between the arm bases, projecting out between the lower portions of the arms; not extending in height beyond the limits of the first ring of plates. Anus central. The plates are frequently ornamented, sometimes nodose, and certain plates spiniferous.

Form of calyx, number and arrangement of plates as in *Eucalyptocrinus*. Dorsal cup composed of four basals; 3×5 primary, $2 \times 2 \times 5$ secondary, and $1 \times 2 \times 10$ tertiary radials; always 3×5 interradials and one interaxillary. Ventral side composed of four rings of plates; the first ring containing five interradials, five interaxillaries, and ten interbrachial pieces. The interbrachials, as a rule, are somewhat larger than those of *Eucalyptocrinus*, and they are provided, like the interradials and interaxillaries, with a projecting brace, but less prominent than those of the other plates. The latter are always stronger, and sometimes extended into a long spine. The twenty braces or partition walls are arranged parallel to each other, and vertically along the median part of the plates. The second ring, if our interpretation is correct, consists of the four large proximals (compare our remarks in *Eucalyptocrinus*); the third ring of the divided oral or central plate and the two smaller proximals, which agree in their form and arrangement with those in *Eucalyptocrinus*. The plates of

the fourth ring, which form the upper
generally composed of four plates, forming
is covered by small pieces surrounding th
are no lateral extensions along these plat
frequently provided with a thickened ri
extended into long spines, which are spre

Arms twenty, not extending beyond t
neck; they are composed of two series
and are provided with long pinnules, co
elongate joints. The arms rest within th
braces, the greater portion of them remai

Column round, composed of rather long
sized, apparently circular canal.

Geological Position, etc.—*Callicrinus* h
from the Upper Silurian of Sweden; it is
some of the casts described from the Niag
represent this genus.

1878. **Callicrinus beyrichianus** Angeln, Iconogr. Cr
Upper Silurian. Gothland, Sweden.

1837. **C. costatus** Hisinger, Eugeniacrinites (?) costa
fig. 14 a b; D'Orbigny, 1850, **Calliocrinus cost**
drome i, p. 45; Angelin, 1878, **Callicrinus co**
p. 16, Pl. 1, fig. 6, and Pl. 2, figs. 1-4; Pl. 21,
26; Pl. 28, figs. 19-22 and 24, 25; also Pl. 29
Silurian. Gothland, Sweden.

1878. **C. diadema** Angelin, Iconogr. Crin. Suec., p. 16
Silurian. Gothland, Sweden.

1878. **C. koninckianus** Angelin, Iconogr. Crin. Suec.,
28, figs. 18-26.—Upper Silurian. Gothland, S

1878. **C. minor** Angelin, Iconogr. Crin. Suec., p. 16, Pl
Gothland, Sweden.

1878. **C. murchisonianus** Angelin, Iconogr. Crin. Suc
28, figs. 14-17.—Upper Silurian. Gothland, S

1878. **C. rœmerianus** Angelin, Iconogr. Crin. Suec., p
28, fig. 23.—Upper Silurian. Gothland, Swed

1878. **C. sedgwickianus** Angelin, Iconogr. Crin. Suec
Silurian. Gothland, Sweden.

CORRECTIONS.

On p. 252 (Ex. Ed., p. 30), 2d line from bottom, read: "*wholly or partly*" before the word "ventrally."

On p. 268 (Ex. Ed., p. 46), 10th line from top, we stated that Prof. Zittel had been the next writer after Prof. Allman, who acknowledged the presence of orals in *Haplocrinus*, *Coccocrinus*, and the Cyathocrinidæ; we discovered however since that Dr. Carpenter already alludes to them in his paper of April, 1879, while Prof. Zittel's Handbuch der Palæontologie appeared in January, 1880.

On p. 275 (Ex. Ed., p. 53), 9th line from top, read: "*peristomeal area*" in place of "tentacular vestibule."

On p. 280 (Ex. Ed., p. 58), 2d line from bottom, after the word *Allagecrinus* insert the following: "*in which the whole ventral side were constructed of actinal plates.*"

On p. 281 (Ex. Ed., p. 59), 13th line from bottom, read: "the latter are *rarely* perforated" in place of "*not* perforated."

On p. 284 (Ex. Ed., p. 62), 16th line from bottom, in place of "and that these Crinoids possessed an orocentral nervous system like all other Echinoderms, except the Neocrinoidea, in which the nervous system, as now generally admitted, is connected with the chambered organ within the basal cavity," insert the following: "*and that perhaps in these Crinoids, contrary to others, and to the Neocrinoidea generally, the entire nervous system was located at the oral side, in conformity with other Echinoderms.*"

On p. 293 (Ex. Ed., p. 71), 4th line from bottom, in place of "were *covered*" read: "were *succeeded*."

On p. 294 (Ex. Ed., p. 72), at the top of page, we expressed our surprise that Dr. P. H. Carpenter admitted calyx interradials in *Apiocrinus roissyanus* and not in *A. Meriani*, *A. Rathieri* and *A. murchisonianus*. On pp. 149–151, and also on p. 183 in the Challenger Report, and wherever Dr. Carpenter speaks of calyx interradials in Neocrinoidea, he refers to the genera *Guettardicrinus*, *Uintacrinus* and to *Apiocrinus roissyanus*, without mentioning the three other well-known species, in which plates are distributed interradially likewise, and in a similar manner. All this led us to the conclusion that he regarded the plates of the latter species as wholly perisomic. Dr. Carpenter informed us since that he never held such view, and that he regards the plates in question in all four species as representing substantially the same thing. It must be further stated that Dr. Carpenter admits in *A. roissyanus* as calyx interradials the whole series of plates up to the top of the second radials, and not only the first plate, as we thought to infer from his figure on p. 150, and from his descriptions. We are pleased to make this correction, at the same time we are at a loss to know where the small plates commence to which the letter i alludes, and which, as stated by Carpenter himself (Challenger Rep., p. 150), "pass gradually upwards into those of the ventral side."

EXPLANATION OF THE PLATES.

The following letters are employed throughout all the plates.

a = azygous plates.
b = basals.
br = brachials.
c = column, and sections of the column.
cd = centrodorsal.
cr = compound radial.
d = interaxillaries.
e = covering plates (Saumplättchen).
h = non-arm-bearing radials.
i = interradials (dorsally and ventrally).
o = oral plate or plates.
p = proximals.
r = radials in the calyx and summit.
r^1 = first radial.
r^2 = second radial.
t = plate of the ventral tube.
u = underbasals.
wp = water-pore.
x = anal plates.
xo = anal opening.
xr = posterior radials enclosed in the ring of proximals.
I = interradially.
IX = azygous interradius.

The diagrams on Plate 6 are designed to show the position of basals and underbasals to the different parts of the column; those of Plates 7 and 8, to show the relation of the summit-plates with each other and with adjoining plates.

EXPLANATION OF PLATE IV.

FIG. 1. *Cupressocrinus abbreviatus* Goldfuss, showing the consolidated muscle-plates, the axial canals, arm openings, and the position of the anal aperture.

FIG. 2. Ventral aspect of *Cyathocrinus Gilesi*. The interradials crowned by tubercles, and resting against the incurved ends of the radials.

FIG. 3. Similar view of another specimen, showing the interradials in the same position, but partly covered by perisomic plates, which connect with the outer edges of the incurved ends of the radials.

FIG. 4. Impression of the ventral side of a specimen of *Teleiocrinus*. The radiating ridges represent paired canals along the inner floor of the test. The original is in the collection of Mr. R. R. Rowley.

FIG. 5 Ventral side of *Dorycrinus Missouriensis*. The ambulacral tubes are exposed only close to the arm-bases, disappearing toward the centre beneath the infiltrating material.

FIG. 6. *Cyathocrinus multibrachiatus*. Ventral surface showing the perisomic plates, portions of the interradials, and the summit plates, the latter in process of resorption.

FIG. 7 *a*. A portion of an arm of the same species. Side plates and covering pieces in position (enlarged).

FIG. 7 *b*. A portion of the same specimen still more enlarged.

FIG. 8. Portion of an arm of *Symbathocrinus dentatus*, showing the ventral furrow and its covering.

FIG. 9. Ventral aspect of *Symbathocrinus Wortheni* after removing the upper half of the first brachials.

FIG. 10. Showing the inner floor of the summit plates in *Symbathocrinus Wortheni*. Seen from below, in a transverse section through the first brachials.

FIG. 11. Cross section of arms and ventral tube at a point midway between the base and tips of the arms, from the same specimen.

EXPLANATION OF PLATE V.

FIG. 1. *Haplocrinus mespiliformis* Goldfuss. Ventral aspect, showing the interradials and anal opening.

FIG. 2. Posterior view of the same specimen.

FIG. 3. Distal face of the bifurcating primary radial of *Forbesiocrinus nobilis*, showing its two axial canals.

FIG. 4. Proximal face of the same.

FIG. 5. Lateral face of an interradial of the same species.

FIG. 6. Ventral aspect of an internal cast of *Batocrinus Christyi*. The dark places represent the pillars suspending the perisome, and the radial ridges the subtegminal ambulacral tubes.

FIG. 7. Ventral aspect of *Cyathocrinus iowensis*. All summit plates bisected or partly resorbed.

FIG. 8. Internal view of the central part of the vault, showing a portion of the perisome, and the peristomeal area beneath the centre of the oral plate, whose sutures are visible in the deeply shaded portion. The figure does not show the specimen as far as the arm bases.

FIG. 9. Ventral aspect of an internal cast of *Platycrinus*. The interradials forming a continuous ring around the proximals, surmounting the covering plates, which emerge from beneath the vault close to the arm bases.

FIG. 10. *Belemnocrinus typus* White. Side view of a perfect specimen, showing the porous ventral tube and the arrangement of arms and pinnules.

FIG. 11. *Belemnocrinus florifer* W. & Sp. Side view of type specimen, showing the arrangement of arms and pinnules; the ventral tube, and the position of the cirrhi.

FIG. 12. *Symbathocrinus Wachsmuthi* M. & W. Ventral aspect, showing the arrangement of the summit pieces and the anal plate.

FIG. 13. Side view of the same specimen, showing the proximals and the radial-dome-plates which alternate with small interradials and together with the former plates rest against the muscle-plates.

FIG. 14. Side view of another specimen, showing the summit plates, interradials, portions of the arms and of the anal tube.

FIG. 15. *Catillocrinus Wachsmuthi* M. & W. A nearly perfect specimen with arms, showing the small anterior and one of the large antero-lateral radials.

FIG. 15 *a*. View of the broken upper end of the same specimen, giving a transverse section of arms and ventral tube.

FIG. 16. Side view of another specimen, showing the dorsal side of the large plates composing the anal tube.

FIG. 17. Underbasal disk of *Agassizocrinus*. Ventral view, showing the ramifying furrows toward the basals, and the six pits within the inner cavity

EXPLANATION OF PLATE VI.

A series of diagrams, showing the position of the lateral cirrhi, that of the axial canals and outer angles of the stem, in monocyclic and dicyclic Crinoids. For better comparison, the upper side is in all these figures interradial, and represents in most cases the azygous side.

FIG. 1. Abactinal aspect of *Xenocrinus*.
FIG. 2. Base of *Reteocrinus*.
FIG. 3. Calyx plates of *Talarocrinus*.
FIG. 4. Calyx plates of *Atelestocrinus robustus*.
FIG. 5. Calyx plates of *Tribrachiocrinus*.
FIG. 6. Base of *Rhodocrinus*.
FIG. 7. Calyx plates of *Carabocrinus*.
FIG. 8. Abactinal aspect of *Millerocrinus Milleri*. After De Loriol.
FIG. 9. Abactinal aspect of *Zeacrinus nodosus*.
FIG. 10. Inner view of the calyx of *Millerocrinus Milleri*, showing the position of the axial canals. After De Loriol.
FIG. 11. Abactinal aspect of the larva of *Antedon rosacea*, shortly before the detachment from the stem. After Dr. W. B. Carpenter.
FIG. 12. Base of *Heterocrinus* and *Stenocrinus*, the column removed.
FIG. 13. Basals of *Stenocrinus*, with a joint of the quinque-partite column.
FIG. 14. Basals of *Heterocrinus*, with a joint of the tri-partite column.
FIG. 15. Basals of *Barycrinus*, with the joint of the quinque-partite column.
FIG. 16. Underbasals and first stem-joint of *Poteriocrinus*.
FIG. 17. Basals and first stem-joint of *Glyptocrinus*.
FIG. 18. Basals and the tri-partite upper part of the stem in *Forbesiocrinus*, *Onychocrinus* and *Taxocrinus*. (The underbasals are covered.)
FIG. 19. Basals and column of *Actinocrinus*, *Batocrinus*, etc.
FIG. 20. Basals and column of *Megistocrinus Evansii*.
FIG. 21. Basals and column of *Dolatocrinus*.
FIG. 22. Basals of *Eucalyptocrinus and Melocrinus*.

FIG. 23. Inner aspect of the calyx of *Ichthyocrinus burlingtonensis*, showing the position of the small underbasal.

FIG. 24. Basals of *Pentremites*, showing the position of the smaller plate.

FIG. 25. Basals of *Platycrinus*, showing the same thing.

FIG. 26. Basals of *Symbathocrinus*, showing the same.

FIG. 27. Column of *Poteriocrinus and Cyathocrinus Harrisi*, with radial cirrhi.

FIG. 28. Column of *Belemnocrinus florifer* with interradial cirrhi.

FIG. 29. Column of *Cupressocrinus*, showing the position of the peripheral canals

FIG. 30. Column of *Pentacrinus* with radial cirrhi.

EXPLANATION OF PLATE VII.

These diagrams are designed to show the relation of the summit plates with each other, and with adjoining plates:—

FIG. 1. Diagram of the plates in the early larva of *Antedon rosacea*. After Dr. P. H. Carpenter.

FIG. 2. Summit plates of *Dorycrinus mississippiensis*.

FIG. 3. Ventral aspect of *Eretmocrinus coronatus*.

FIG. 4. Summit plates of *Amphoracrinus spinobrachiatus*.

FIG. 5. Ventral aspect of *Platycrinus glyptus*.

FIG. 6. The same of *Platycrinus subspinosus*.

FIG. 7. The same of *Platycrinus Halli*.

FIG. 8. The same of *Platycrinus tuberosus*.

FIG. 9. The same of *Agaricocrinus Wortheni*.

FIG. 10. The same of a large specimen of *Agaricocrinus americanus*. The dorsal interradials are attached on three sides.

EXPLANATION OF PLATE VIII.

FIG. 1. Internal cast of *Strotocrinus regalis*, showing the impression of the radiating canals along the inner floor of the vault, and the presence of three summit radials between each proximal.

FIG. 2. Internal cast of *Actinocrinus multiradiatus*, showing the same as fig. 1, however, with two summit radials anteriorly and three posteriorly. (The pentapartite protuberance along the oral plate is too prominent in the figure).

FIG. 3. Internal cast of a specimen of *Teleiocrinus*, showing the same as fig. 1.

FIG. 4. Ventral aspect of *Steganocrinus concinnus*.

FIG. 5. Ventral aspect of *Megistocrinus Evansii*.

FIG. 6. Ventral aspect of *Platycrinus burlingtonensis*.

FIG. 7. Ventral aspect of *Marsupiocrinus Tennesseæ*.

FIG. 8. Ventral aspect of *Batocrinus subæqualis*.

[illegible]

[illegible]

[illegible]

[illegible]

AUGUST 4.

Mr. CHARLES MORRIS in the chair.

Nineteen persons present.

Note on Quercus prinoides Willd.—Mr. MEEHAN exhibited a series of fruiting specimens of branches of *Quercus prinoides*. In some, the leaves were almost orbicular and obtuse; in others narrowly lanceolate or saliciform and acute; others had lobed and wavy edges, while others were quite entire. The plants were all growing within a few feet of each other, and the parent plants were also all under the same conditions of environment, and were at no distant date from one parentage.

They were exhibited for two purposes—first, to show that environment, as commonly understood, was not a main factor in the origination of variation; and secondly, to show that variation was independent of mere conditions of growth or sexual peculiarities to which variation was sometimes referred. It was, indeed, true, that young plants often had leaves varying from those on the older plants, and plants or branches bearing flowers of one sex would have characters varying from those of another sex; but these specimens were all fertile, and with young acorns. There was no possible ground for any suggestion as to different conditions in any sense, and the variations could be only attributed to an innate and wholly unknown power to vary, which science had so far been unable to reach.

AUGUST 11.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Eighteen persons present.

On the Fruit of Opuntia.—Mr. THOMAS MEEHAN exhibited a series of specimens of an unknown species of *Opuntia* closely allied to *O. Brasiliensis*, showing a gradual change from the joint or frond to the fruit. In one case there was the thin orbicular frond; then a frond with a slight rounding and tapering at the base; then one somewhat resembling a fruit, but very much compressed, and with an abortive flower-bud leaving a scar at the apex; then another, but very much elongated and fluted, and with a perfect flower, though small; and, lastly, the frond reduced to an inch in length, pyriform, and with the perfect, large yellow flower. He remarked that it could not be called a novel point to make that the fruit of a cactus was simply a

metamorphosed frond, or joint as the section is commonly called, and that the petals were the usually (in the frond) very much suppressed leaves; but it might serve a good purpose to place on record this excellent illustration of the fact.

AUGUST 18.

Mr. CHARLES ROBERTS in the chair.

Fifteen persons present.

A paper entitled "A Review of the Species of the Genus Esox," by Seth E. Meek and Robert Newland, was presented for publication.

The following deaths were announced:—

Moro Phillips, a member, August 9, 1885.

Rud. Wm. Dunker, a correspondent, March 13, 1885.

SEPTEMBER 1.

Mr. THOS. A. ROBINSON in the chair.

Twenty persons present.

The following was ordered to be printed:—

A REVIEW OF THE SPECIES OF THE GENUS ESOX.

BY SETH E. MEEK AND ROBERT NEWLAND.

In the present paper is given the synonymy of the species of the genus *Esox*, with an analytical key by which the species can be determined. The specimens which we have studied belong to the Indiana University.

We acknowledge our indebtedness to Professor Jordan, for the use of his library and for other aids.

Genus ESOX.

Esox Artedi, Genera 14, 1738 (includes the modern genera *Esox*, *Belone* and *Lepidosteus*).

Esox, Linnæus, Systema Naturæ, 1758, 314 (*lucius*, etc.).

Lucius,[1] Rafinesque Idice d'Ittiol. Sicil, 1810 (*lucius*).

Picorellus, Rafinesque, Ichthiol. Ohioensis, 1820, 70 (*vittatus*) *salmoneus* (subgenus).

Mascalongus, Jordan, Klippart's Second Rept. Ohio Fish Comm., 1878, 92 (*nobilior-masquinongy*) (subgenus).

Analysis of Species of Esox.

a. Cheeks and opercles entirely scaly.

b. Branchiostegals normally 12 (11 to 13); scales in the lateral line 105 to 108; D. 11 or 12; A. 11 or 12; middle of eye nearer tip of lower jaw than posterior margin of opercle.

c. Head short, $3\frac{4}{7}$ in length of body; snout $2\frac{1}{2}$ in length of head; eye $2\frac{2}{3}$ in length of snout. Color dark green; sides with about twenty distinct blackish curved bars; fins plain. *Americanus*. 1.

cc. Head longer, $3\frac{1}{4}$ in length of body; snout $2\frac{1}{5}$ in length of head; eye $2\frac{1}{2}$ in length of snout. Color greenish, sides with many narrow curved darker streaks, usually distinct and more or less reticulated; fins mostly plain. *Vermiculatus*. 2.

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[1] The name *Esox* is in this paper restricted to *Esox belone* L., the type of the genus *Belone* Cuvier, while the name *Lucius* is reserved for the pikes. The name *Esox* has been universally associated with the Pikes rather than with the Gar-fishes, but perhaps in strict technicality, the name *Lucius* should be used for the former and that of *Esox* for the latter. It is perhaps not unfair, however, to assume that Linnæus would have considered the Pike, rather than the Gar-fish, as typical of his genus *Esox*.

bb. Branchiostegals 14 to 16; D. 14;
line about 125; middle of eye
lower jaw and posterior margin o
in length of body; snout $2\frac{1}{3}$ in
Color greenish, marked with num
and streaks which are mostly hor
less reticulated, fins plain

aa. Cheeks scaly; lower half of opercle b
to 16; D. 16 or 17; A. 13 or 14; s
head $3\frac{1}{3}$ in length of body; snout 2
3 in length of snout; middle of eye
lower jaw and posterior margin of
with many whitish spots, the you
and caudal fins spotted with black
bounding the naked portion of ope

aaa. Cheeks as well as opercles bare on
gals 17 to 19; D. 17; A. 15; scales
150; middle of eye midway betw
posterior margin of opercle; hea
snout $2\frac{1}{3}$ in head; eye more than
snout. Color dark gray, sides wit
fins spotted with black.

1 **Esox americanus**

Esox americanus Schoepf, "Naturforscher
Island).

Esox lucius 3 americanus Gmelin, Systema
on Schoepf).

Esox americanus Lacépède, Hist. Nat. P
and Valenciennes, Hist. Nat. Poiss., xvii
Jordan, Annals N. Y. Acad. Nat. Hist
(Delaware River; Long Island); Jordan,
ix, 1878, 432; Bean, Proc. U. S. Nat. Mu
Georgia), Goode and Bean, Bull. Essex I
ham Lake, Mass.), Bean, Bull. U. S. Fi
mont, N. Y.; Trenton, N. J.; Long Isla
iii, 1880, 267; Goode, Bull. U. S. Nat.
and Gilbert, Syn. Fish. N. A., 1882, 35
50, 1885

Picorellus americanus Jordan and Copela
Sci., 1876, 143 (Check List).

Esox niger Le Sueur, Jour. Acad. Nat. S
Carolina).

Esox scomberius Mitchill, Amer. Monthly Mag., 1818, 322 (Murderer's Creek, N. Y.); De Kay, N. Y. Fauna, Fish, 1842, 225 (copied).

Esox fasciatus De Kay, N. Y. Fauna, Fish, 1842, 224, pl. 34, fig. 110 (Long Island).

Esox ornatus Girard, "Proc. Bost. Soc. Nat. Hist., 1854, 41" (Massachusetts); Storer, Hist. Fish, Mass., 1867, 313 (Boston market).

Esox ravenelii Holbrook, Ichthyol. S. C., 1855, 201 (South Carolina); Cope, Proc. Acad, Nat. Sci. Phila., 1865, 79 (Catawba River); Cope, Proc. Amer. Phil. Soc., 1870, 457 (Catawba River); Günther, Cat. Fish, Brit. Mus., vi, 1866, 230 (copied); Jordan, Annals N. Y. Lyceum Nat. Hist., vol. xi, 1877, 368 (Coosa R., Georgia); Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 16 (Catawba River); Goode, Proc. U. S. Nat. Mus., 1879, 117.

Picorellus ravenelii Jordan & Copeland, Bull. Buffalo Soc. Nat. Sci., 1875, 143 (Check list).

Habitat.—Coastwise streams from the Charles River, Mass., to the Savannah River, Georgia.

The specimen examined by us is from the market.

The synonymy of the species offers little room for question, although some of the earlier descriptions are very scanty.

2. **Esox vermiculatus.**

Esox vermiculatus (Le Sueur MSS.) Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 333 (Wabash Valley); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 110; Forbes, Ill. State Fish Comm., 1884, 71 (Illinois); Gilbert, Proc. U. S. Nat. Mus., 1884, 209 (East Fork of White River, Indiana); Gilbert, Proc. U. S. Nat. Mus., 1884, 208 (Switz City Swamp, Greene Co., Indiana); Jordan, Cat. Fish. N. A., 50, 1885.

Esox lineatus (Le Sueur MSS.) Cuvier & Valenciennes, Hist. Nat. Poiss., 1846, 335 (Wabash Valley, young).

Esox umbrosus Kirtland, "Cleveland Annals of Sciences, 1854, 79" (near Cleveland, Ohio); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79; Cope, Trans. Amer. Phil. Soc., 1866, 409 (Grosse Isle, Michigan); Hay, Bull. U. S. Nat. Mus., 1882, 67, 74 (Memphis; Jackson; Vaughans; Granada).

? *Esox crassus* Agassiz, Amer. Jour. Sci. & Arts, 1854, 308 (Tennessee River, at Huntsville, Alabama); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79 (copied); Jordan & Copeland, Bull. Buffalo Soc. Nat. Sci., 1876, 143 (Check list).

Esox cypho Cope, Proc. Acad. Nat. Sci. Phila., 1865, 78 (Waterford, Oakland Co., Michigan); Günther, Cat. Fish. Brit. Mus., vi, 1866, 230 (copied); Jordan Annals N. Y. Acad. Sci., vol. i, No. 4, 1877, 368 (Fox River, Illinois); Nelson, Bull. Ill. Mus. Nat. Hist., i, 1877, 43 (Fox River at Geneva); Jordan, Bull. U. S. Geol. Sur. Terr., iv, 1878, 432; Jordan, Man. Vert. Ed., iii, 1880, 267.

Picorellus cypho Jordan & Copeland, Bull. I
143 (Check List).

? *Esox niger* Günther, Cat. Fish. Brit. Mu
leans), not of Le Sueur.

Esox porosus Cope, Trans. Amer. Phil.
Michigan).

Esox salmoneus Jordan, Bull. Buffalo, Soc.

Esox salmoneus Jordan, Annals N. Y. Aca
104 (White River; Ohio River, Illinois R
mee River; Lake Erie); Jordan, Bull. U
Jordan Annals N. Y. Lyceum, vol. xi, 18
diana); Jordan, Proc. Acad. Nat. Sci. I
Laporte County, Indiana; St. Joseph's
River, Indiana; Tippecanoe River, Indian
Nat. Hist., i, 1877, 43 (Illinois); Jordan,
ii, 1878, 63; (Illinois River at Pekin; Fox
Jordan Syn Fish. N. A., 1882, 352; Jord
1882, 914 (not of Mitchill; probably not o

Picorellus salmoneus Jordan, Man. Vert. Ed
land, Bull. Buffalo Soc. Nat. Sci., 1876, 1

Esox ravenelii Jordan, Bull. Ill. Mus. N
County, Illinois) not of Holbrook).

Habitat.—Mississippi Valley and Gre
abundant in the central States. Not foun
Mountains, nor in the Texan region.
waters and bayous.

The specimens examined by us are fro
River, Southern Indiana; Bean Blossom
diana; Pipe Creek, Madison County, I
County, Indiana; Kankakee River at I
Hicksville, Defiance County, Ohio.

This species has the general coloration
its other characters, very close to those of
the latter species it differs but slightly, b
the snout, small as it is, seems to be very

The name *Esox salmoneus*, frequently
cannot be retained, as it was earlier given
fisteus. It is also probable that Rafinesc
is a mythical species, not identifiable with
of the original drawing (in his MSS. note
the dorsal is said to be represented as n
of the snout and the base of the caudal.

3. **Esox reticulatus.**

Esox lucius Mitchill, Trans. Hist. & Phil. Soc. N. Y., 1815, 440 (Long Island).

Esox reticulatus Le Sueur, Jour. Acad. Nat. Sci. Phila., 1818, 414, No. 2 (Philadelphia); Storer, Rept. Fish. Mass., 1839, 97 (Maine; Massachusetts); De Kay, N. Y. Fauna Fish., 1842, 223 (New York); Ayres, Bost. Jour. Nat. Hist., iv, 1842, 269 (Brookhaven, Long Island; Hockanum River, Conn.).

Esox reticulatus Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 327 (Philadelphia; Charleston, S. C.); Storer, Syn. Fish. N. A., 1846, 437; Thompson, "Hist. of Vermont, 1846, 138" (Vermont); Griffiths Cuvier. Regne Animal, 1854, 390; Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79; Cope, Trans. Amer. Phil. Soc. Phila., 1866, 410; Günther, Cat. Fishes Brit. Mus., vi, 1866, 229 (Boston; New York); Storer, Hist. Fish. Mass., 1867 (Maine; Massachusetts); Jordan, Ohio State Fish Comm., 1876, 186.

Esox reticulatus Jordan, Annals N. Y. Acad. Sci., vol. i, No. 4, 1877, 104 (Westfield River; Delaware River; Ocmulgee River; Etowah River; Potomac River); Jordan, Bull. U. S. Geol. Sur. Terr., iv, 1878, 432; Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 40 (Etowah River); Jordan & Brayton, Bull. U. S. Nat. Mus., xii, 1878, 16; Goode, Proc. U. S. Nat. Mus., 1879, 117; Goode & Bean, Bull. Essex Institute, vol. ix, 1879, 22 (Massachusetts); Goode, Bull. U. S. Nat. Mus., xxi, 1880, 32 (East Wareham, Massachusetts); Bean, Proc. U. S. Nat. Mus., 1880, 104 (Norfolk, Va.; South Hadley Falls, Mass.); Jordan, Man. Vert., Ed. 3, 1880, 267; Hay, Bull. U. S. Nat. Mus., 1882, 67, 74 (Big Black River, Mississippi; Pearl River, Mississippi); Jordan & Gilbert, Syn. Fish. N. A., 1882, 353; Jordan, Cat. Fish. N. A., 50, 1885.

Picorellus reticulatus Jordan & Copeland, Bull. Buffalo Soc. Nat. Hist., 1876, 143 (Check list).

? *Esox phaleratus* (Say) Le Sueur, Jour. Sci. Phila., 1818, 416 (near St. Augustine, Fla.); De Kay, N. Y. Fauna Fish, 1842, 226 (copied); Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 333 (copied).

? *Esox phaleratus* Goode, Proc. U. S. Nat. Mus., 1879, 117.

Esox tridecem-lineatus Mitchill, ? "Mirror, 1825, 361" (Oneida Lake).

Esox tridecem-radiatus DeKay, N. Y. Fauna. Fish., 1842, 225 (copied).

Esox affinis Holbrook, "Ichth. South Car., 1855, 198" (South Carolina); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79 (Neuse River); Cope, Proc. Amer. Phil. Soc., Phila., 1870, 457.

Picorellus affinis Jordan & Copeland, Bull. Buffalo. Soc. Nat. Sci., 1876, 143 (Check List); Jordan, Man. Vert., 1876, Ed. i, 255.

Esox reticulatus var. *affinis* Jordon Annals, N. Y. Lyceum Nat. Hist., vol. xi, 1877, 369 (Etowah River, Georgia).

Habitat.—Maine to Mississippi, chiefly or only in streams and lakes east of the mountains.

The specimens examined by us are from the Potomac and Delaware Rivers.

4. **Esox lucius.**

*Esox lucius** Linnæus, Systema Naturæ, Ed. x, 1758, 314 (European specimens).

American References.

? *Esox lucius* Richardson, "Fauna Bor. Amer. Fishes, iii, 1836, 124" (Northern regions); De Kay, N. Y. Fauna, Fish., 1842, 226 (copied).

Esox lucius Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79; Cope, Trans. Amer. Phil. Soc. Phila., 1866, 408 (Great Lakes; Lake Whittlesey, Minnesota); Günther, Cat. Fish. Brit. Mus., vi, 1866, 227 (Albany River; Lake Whittlessey, Minnesota; Arctic, N. A.); Jordan & Copeland, Bull. Buffalo Soc. Nat. Sci., 1876, 143 (Check List); Jordan, Ohio State Fish. Comm., 1876, 166, fig. 16, pl. 11; Jordan, Bull. U. S., Geol. Sur. Terr., iv, 1876, 797 (Turtle Mountain; St. Mary's River, Rocky Mountains); Jordan, Proc. Acad. Nat. Sci. Phila., 1877, 44 (St. Joseph's River, Indiana); Jordan Annals, N. Y. Acad. Sci., vol. i, No. 4, 1877, 104, (Lake Ontario; Lake Erie; Lake Michigan; Fox River, Illinois; Mississippi River); Jordan, Bull. U. S. Nat. Mus., x, 1877, 55; Jordan, Bull. U. S. Geol. Sur. Terr., 1878, 432.

Esox lucius Jordan, Bull. Ill. Mus. Nat. Hist., ii, 1878, 53 (Rock River, Ill.), Jordan, Man. Vert. Ed. 3, 1880, 266; Bean, Proc. U. S. Nat. Mus., 1880, 104 (Sandusky, Ohio; South Hadley Falls, Massachusetts); Goode, Bull. U. S. Nat. Mus., 21, 1880, 32 (Sandusky, Ohio); Bean, Proc. U. S. Nat. Mus., 1881, 255, 268, 271 (Alaska; Youkon River); Jordan, Zöology of Ohio, iv, 1882, 915; Jordan & Gilbert, Syn. Fish. N. A., 1882, 358; Forbes, Ill. State Fish Comm., 1884, 71 (Illinois); Jordan, Cat. Fish. N. A., 51, 1885.

?? *Esox vittatus* Rafinesque, American Monthly Mag., vol. iii, 1818, 447; Rafinesque, Ichth. Oh., 1820, 70 (Mythical).

Esox Estor Le Sueur, Jour. Acad. Nat. Sci. Phila., 1818, 413 (Lake Erie); DeKay, N. Y. Fauna Fish. 1842, 222; Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 324, pl. 542 (Lake Erie); Günther, Cat. Fish. Brit. Mus., 1866, 228 (copied).

Esox lucius var. *estor* Jordan, Man. Vert., 1876, 255; (Nelson, Bull. Ill. Mus. Nat. Hist., i, 1876, 43 (Northern Illinois); Jordan & Copeland, Bull. Buffalo Soc. Nat. Sci., 1876, 43 (Check List).

Esox reticulatus Kirtland, "Zöology of Ohio, 1820, 194;" Kirtland, "Bost. Jour. Nat. Hist., 1848, 83, pl. 10, fig. 2" (Lake Erie); (not of Le Sueur).

?? *Esox salmoneus* Rafinesque, Ichthiol. Ohiensis, 1820, 70 (Mythical).

* The European synonymy of this species is very extensive, and we have not attempted to collect it.

Esox deprandus (Le Sueur MSS.) Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 336 (Wabash River at New Harmony, Indiana); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79; Cope, Trans. Amer. Phil. Soc. Phila., 1866, 408 (copied); Günther, Cat. Fish. Brit. Mus., 1866, 229 (copied); Jordan, Proc. U. S. Nat. Mus., 1879, 225 (Identification of Le Sueur's type).

? *Esox lugubrosus* (Le Sueur MSS.) Cuvier & Valenciennes, Hist. Nat. Poiss., xviii, 1846, 338 (Crab Orchard, Ky.; no description).

Esox lucioides "Agassiz & Girard," Herbert Frank Forester's Fish and Fishing, 1849 (Lake Superior).

Esox boreus Agassiz, "Lake Superior, 1850, 317" (Lake Superior; same as *E. lucioides*); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79: Nelson, Bull. Ill. Mus. Nat. Hist., i, 1877, 43 (Northern Illinois).

Habitat.—Streams and lakes of Europe; Northern Asia, Alaska, and Northeastern parts of North America; South to New York and Ohio River, and west to the Rocky Mountains.

The specimens examined by us are from Venice, Lake Erie, and Lake Michigan.

We can see no difference whatever between American and European examples of this species, when specimens of similar size and condition are compared. The names *Esox estor*, *deprandus*, *lucioides* and *boreus* are therefore strictly synonymous with *E. lucius*.

5. **Esox masquinongy.**

Esox masquinongy Mitchill, "Mirror, 1824, 297" (but the description is said not to be there); Kirtland, Zoölogy of Ohio, 1838, 194 (Lake Erie).

Esox estor Richardson, "Fauna Bor. Amer., iii, 1836, 127" (Lake Huron); Kirtland, Bost. Jour. Nat. Sci., 1842, 329; Agassiz, "Amer. Jour. Sci. & Arts, xvi, 1853, 308" (not *Esox estor*, Le Sueur).

Esox nobilior Thompson, "Proc Bost. Soc. Nat. Hist., iii, 1850, 163, 173, 305" (Lake Champlain); Cope, Proc. Acad. Nat. Sci. Phila., 1865, 79; Cope, Trans. Amer. Phil. Soc. Phila., 1866, 410 (Coneaught Lake, Pa.; Alleghany River); Jordan & Copeland, Bull. Buffalo Soc. Nat. Sci., 1876, 143 (Check list); Jordan, Annals N. Y. Acad. Sci., vol. i, No. 4, 1877, 104 (Lake Michigan; Lake Huron; Lake Erie); Jordan, Bull. U. S. Nat. Mus., 1877, 54 (Ecorse, Michigan; Lake Huron); Nelson, Bull. Ill. Mus. Nat. Hist., i, 1877, 43 (Lake Michigan); Jordan, Man. Vert., Ed. ii, 1878, 266; Jordan, Bull. Ill. Mus. Nat. Hist., 1878, 53 (Lake Michigan); Goode, Bull. U. S. Nat. Mus., xiv, 1879, 55; Goode, Bull. U. S. Nat. Mus., xxi, 1880, 32 (Sandusky, Ohio; Jordan, Man. Vert., Ed. iii, 1883, 266; Bean, Bull. U. S. Fish Comm., 1880, 104 (Sandusky, Ohio); Bean, Proc. U. S. Nat. Mus. 1880, 104 (Sandusky, Ohio).

Esox nobilior Jordan, Zoölogy of Ohio, vol. IV, 1882, 917; Jordan & Gilbert, Syn. Fish. N. A., 1882, 353; Forbes, Ill. State Fish Comm., 1884, 71 (Lake Michigan); Jordan, Cat. Fish. N. A., 51, 1886.
? *Esox ohiensis* Kirtland, "Cleveland Annals of Science, 1854."

Habitat.—Great Lakes, occasionally in the Ohio and Upper Mississippi Rivers.

One specimen examined by us is from the Ohio River at New Albany, Indiana.

We here adopt the name *Esox masquinongy* of Mitchill for this species instead of the more familiar and preferable *Esox nobilior* of apparently later date.

Professor Jordan has been unable to find the description of Mitchill in the files of the Mirror, where it is said by De Kay to occur. A portion of the description of Mitchill is quoted by De Kay, and this part applies to the Muskalunge much better than to the Pikes. Moreover, reference to Mitchill's name is made by Kirtland at a date prior to the publication of the work of De Kay.

It is therefore highly probable that a description of *Esox masquinongy* has been somewhere printed by Mitchill, and if so, that this is the earliest account of the Muskalunge.

The descriptions of *Esox ohioensis* is said to refer to this species, but we have not been able to examine the original paper of Dr. Kirtland.

List of Nominal Species with Identifications.

The following is a list of nominal species referred to in the foregoing paper, arranged in chronological order with our identification of each. Tenable specific names are printed in italics.

Nominal Species.	*Date.*	*Identification.*
Esox lucius Linnæus,	1758,	Esox lucius.
Esox americanus Gmelin,	1788,	Esox americanus.
Esox reticulatus Le Sueur,	1817,	Esox reticulatus.
Esox niger Le Sueur,	1817,	Esox americanus.
Esox estor Le Sueur,	1818,	Esox lucius.
Esox vittatus Rafinesque,	1818,	(mythical).
Esox phaleratus Say,	1818,	Esox reticulatus ?
Esox scomberius Mitchill,	1818,	Esox americanus.
Esox salmoneus Rafinesque,	1820,	(mythical).
Esox masquinongy Mitchill,	1824,	Esox masquinongy.
Esox tredecem-lineatus Mitchill,	1825,	Esox reticulatus.

Nominal Species.	*Date.*	*Identification.*
Esox fasciatus De Kay,	1842,	Esox americanus.
Esox tredecem-radiatus De Kay.	1842,	Esox reticulatus.
Esox vermiculatus Le Sueur.	1846,	Esox vermiculatus.
Esox lineatus Le Sueur,	1846,	Esox vermiculatus.
Esox deprandus Le Sueur,	1846,	Esox lucius.
Esox lugubrosus Le Sueur,	1846,	Esox lucius?
Esox lucioides Agassiz & Girard,	1849,	Esox lucius.
Esox boreus Agassiz,	1850,	Esox lucius.
Esox nobilior Thompson,	1850,	Esox masquinongy.
Esox crassus, Agassiz,	1854,	Esox vermiculatus?
Esox umbrosus, Kirtland,	1854,	Esox vermiculatus.
Esox ohioensis, Kirtland,	1854,	Esox masquinongy?
Esox ornatus, Girard,	1854,	Esox americanus.
Esox affinis Holbrook,	1855,	Esox reticulatus.
Esox ravenelii Holbrook,	1855,	Esox americanus.
Esox cypho Cope,	1865,	Esox vermiculatus.
Esox porosus Cope,	1866,	Esox vermiculatus.

SEPTEMBER 8.

Dr. A. E. FOOTE in the chair.

Twelve persons present.

Inflorescence of the Compositæ.—At the meeting of the Botanical section, on the seventh inst., Mr. THOMAS MEEHAN remarked that it seemed obvious, by the rule in Asteraceous plants, or the order *Compositæ*, that the order of anthesis was inversely to the growth. But by a note of Prof. Asa Gray in his new synoptical *Flora of North America*, referring to *Liatris*, it did not appear to have received the marked attention of botanists. Among the generic characters of *Liatris*, Dr. Gray gives flowering from the top downwards, as in an inverted spike or raceme. He exhibited specimens of *Mulgedium*, *Lactuca*, *Erecthites*, *Gnaphalium*, *Aster*, *Solidago*, *Vernonia*, *Erigeron*, *Bidens*, and *Xanthium*, all gathered casually and hastily within a few yards of each other, to show that the upper or terminal flower was the first to open, then the upper flower on the next branch of the raceme or panicle, and then the lower ones in succession. If in these plants the side branches were arrested in their growth, and the terminal flowers of the branchlets brought down in proximity to the main stem, we had precisely the same kind of anthesis as in *Liatris*. If *Liatris* had a branched panicle instead of a spicate inflorescence, we should not notice any difference between it and other plants. There were some other families of plants that presented a similar order of anthesis, but it is so marked a character in *Compositæ* as to make it well worthy of consideration in connection with the peculiar construction of the flower heads.

A remarkable reflection is that this completion of growth, and their flowering down the stems backwards, ceases with the formation of the flower heads. Then the anthesis of the florets is with and not reversely to the growth. In a sunflower, for instance, any one may remember that the florets near the ray open first, and continue to open spirally until the centre is reached.

There were, however, exceptions in compositæ to the order of anthesis in the flower heads. In *Ambrosia* the lower flowers on the spike opened first, and they continued to open upwards as in the raceme of any other order of plants. In the female plants of *Ambrosia artemisiæfolia*, being abundant this season (1885) the truly racemose order of opening was the same as in the ordinary monœcious plants.

SEPTEMBER 15.

Mr. CHARLES MORRIS in the chair.

Twenty-three persons present.

On the Pectoral Filaments in the Sea Robin (*Primotus palmipes*).—Dr. Harrison Allen said, in speaking of the pectoral fin of the family of teliostean fishes, the Triglidæ, that the first three rays are known as the pectoral filaments. They are disposed ventrally, separated from the body of the fin, and placed well in front of its base. The filaments are curved somewhat upon themselves, and are moved by powerful muscles. The nerves supplying them are derived from the ganglionic masses (so characteristic of the Triglidæ) at the beginning of the spinal cord. The filaments are used not only for touch but for locomotion. In directing the body toward the right, the left filaments are in constant motion (like the limbs of a salamander) while the right filaments are at rest. In directing the body toward the left, the motion thus described is reversed. The filaments are also used in stirring up the soft silt which composes the bottoms on which the fish rests. The organs are thus put to comparative rough usage, so that one learns with a sense of surprise that the tops and sides near the tips possess a high degree of differentiation of the tegument. The organ, while appearing to be tactile in nature, recalls in character the general features of a retinal surface. Both in longitudinal and in transverse section the organ is seen to be composed of four layers of cells. The first basal layer is made up of small nearly round cells. The second layer is composed of large fusiform cells, each of which contains granular contents surrounding a distinct circular nucleus. The third layer is composed of columnar cells resembling finger-like processes which are arranged like a layer of retinal rods. A connective tissue membrane which might be compared to the external limiting membrane of the retina intervenes between the third and second layer of cells. The fourth and peripheral layer is composed of diaphanous tube-like prolongations of the side of the cells which compose the third layer. It varies greatly in thickness. In some portions of each filament the fourth layer is very thin, and barely covers the tips of the processes of the third layer, or it is of a thickness nearly equal to one-half the thickness of the entire organ. The layer appears to be tightly held to the third, and is often detached in the sections. The general membrane is smooth and uniform at the tips of the filaments, but is arranged in broad capitate papillæ elsewhere.

The recorder thought the pectoral filaments to be beautiful objects for study. They can be readily obtained since the sea-robin is a common summer fish along the Atlantic coast.

SEPTEMBER 22.

The President, Dr. LEIDY, in the chair.

Twenty-five persons present.

SEPTEMBER 29.

Mr. J. H. REDFIELD in the chair.

Twenty-five persons present.

OCTOBER 5.

Mr. GEO. W. TRYON, JR., in the chair.

Twenty-four persons present.

A paper entitled "Attack and Defence as Agents in Animal Evolution," by Charles Morris, was presented for publication.

OCTOBER 13.

The President, Dr. LEIDY, in the chair.

Thirty-four persons present.

Notes on Cactaceæ.—Elastic Fruit in Mamillaria.—At the meeting of the Botanical Section of the Academy, held on the 12th inst., Mr. MEEHAN referred to his former observations on the sudden growth of the fruit of some species of cactaceæ, indicating that it was not a growth before maturity, but an elastic projection of a fruit already mature. Since that time he had been able to note in *Mamillaria gladiata*, *M. recurva*, and some other Mexican species, in which there was only the apex of the red fruit visible between the mamma over night, a full elongation to the length of an inch by 9 A. M. the next day. They were clear cases of the elongation of the fruit after maturity and not a growth.

The flowers of *Opuntia Rafinesqui* had very irritable stamens when the flowers were fully expanded under a bright sun. Some echinocacti had stamens irritable in a less degree, but in *Echinocactus erinaceus* the stamens were quite as irritable as in the *Opuntia* noted.

On the Flora of Martha's Vineyard and Nantucket.—At the same meeting of the Botanical Section Mr. REDFIELD spoke of the topographical features of Martha's Vineyard and Nantucket, in connection with the flora of those islands. The northern portion of the island of Martha's Vineyard rises into rounded hills of considerable elevation, composed of gravelly drift, strewn occasionally with large boulders. They are evidently

of glacial origin. The more central portion consists of level plains of gravel, covered with oaks, mostly *Quercus obtusiloba*. The general character of the flora is much like that found on the summit of the divides in southern New Jersey, though much more limited as to species. Farther south, extensive ponds, both of fresh and salt water, introduce their characteristic vegetation. In Nantucket he had found the gravelly hills of much less height, the greater portion of the island consisting in fact of treeless plains—one extensive grove of *Pinus rigida* exists in the central portion of the island, and is known to have been planted. The plains alluded to were many years ago occupied as sheep pastures. But of late years this has been prohibited, and it is said that since then there has been a great change in the character of the vegetation. The most characteristic plant of these plains seemed to be *Arctostaphylos uva-ursi*, which grows there in greater profusion than he had ever seen it. The two species of *Hudsonia* abound, the *H. ericoides* being seen everywhere, and less frequently the more bluish-green tufts of *H. tomentosa*. *Polygala polygama*, *Myrica cerifera* and various *Vaccineæ* abound. He saw many large patches of *Corema Conradii*, the existence of which in Nantucket had first been made known by Mrs. Owen of Springfield, Mass. But the most interesting feature is the existence here of three species of heath, possibly indigenous. Mrs. Owen, who published a preliminary catalogue of the Nantucket flora a few years ago, records *Calluna vulgaris* and *Erica cinerea* as found upon the island. The first of these had long been known to occur at Tewksbury, Mass., and there had been some question as to whether its presence there was due to human agency. Its subsequent discovery in Nova Scotia and Newfoundland had seemed to strengthen the idea of its indigenous character. Mr. R. did not see the locality of *Calluna vulgaris*, but had the privilege of seeing that of the *Erica cinerea*. This plant had been known and watched for 10 or 12 years, and is evidently an old one. It grows in the open common—far away from the town—and there is nothing about its surroundings to indicate human introduction. It covers only a space of eight inches by ten.

Since Mr. Redfield's visit the third species *Erica tetralix* had been discovered in a locality very distant from that of *E. cinerea*, but under circumstances which favor the idea of its accidental introduction in connection with the importation of foreign trees. But there are said to be seven or eight of the plants all thriving, large and bushy.

OCTOBER 20.

The President, Dr. LEIDY, in the chair.

Twenty-eight persons present.

OCTOBER 27.

The President, Dr. [illegible], i

[illegible]

[illegible] were presented [illegible] of American Gasteropo[illegible]

[illegible] of the Fishes of [illegible] [illegible] H. Eigenmann and M[illegible] [illegible] collected in Harvey [illegible] Evermann and Morto[illegible] [illegible] of the American species [illegible] [illegible] and Seth E. Meek.

[illegible] of the American species [illegible] [illegible] and Robert Newland.

[illegible] committee appointed to settle the [illegible] under whose will [illegible] M[illegible] [illegible] entire after the de[illegible] [illegible] Johnson and [illegible] [illegible] value of the entire estate [illegible] present income from the [illegible] is $1,[illegible].

The following resolution was unanimo[illegible]

Resolved, That the thanks of the Acad[illegible] [illegible] Butler and to Uselma C. S[illegible] [illegible] Academy for their careful and [illegible] [illegible] of the Johnson estate.

The following was ordered to be print[illegible]

BIOGRAPHICAL NOTICE OF HENRY N. JOHNSON.

BY THOMAS MEEHAN.

In the central part of Germantown, on what is known as "The battle-ground," is "Upsal," the estate of John Johnson, the descendant of Dirk Jansen, an early settler in that borough. The residence is some five hundred feet west of the celebrated Chew Mansion, in which a number of British troops fortified themselves in the war of the Revolution to resist the advance of General Washington's army towards Philadelphia. In front of John Johnson's house the cannon were placed that were used by the American army in the attack on the Chew House. The estate was known as "Upsal," a name associated with the great Swedish botanist Linnæus; but in this case given from its being the birthplace of Mrs. John Johnson.

A love of botany, or at least of rare trees and plants, must have been a trait in the character of John Johnson, for when the writer first knew it, about 1856, it was, in many regards, a botanic garden, in respect to the number of rare herbaceous plants growing there, while some of the finest specimens of rare trees to be found about the city, adorned the grounds. At that time it contained a specimen of the European silver fir, which the writer measured and found over ninety feet high; a very large deciduous cypress, by examining which the late Dr. Engelmann made his first discovery of the fact that at least one coniferous plant imitated amentaceous plants in advancing considerably male flower buds in the fall; magnolias, and especially a specimen of the American yew, which remains to this day probably the finest specimen of this plant in the world. These trees, according to the statement of Henry N., the son and subject of this sketch, were planted by John Johnson about the year 1800.

Henry N. was born on the 20th of May, 1820. He completed his education in the old Germantown Academy in 1839. He was noted among his schoolmates for a studious disposition, and in the classics, literature, and mathematics, particularly, kept at the head of his class. Entering manhood he started, in connection with a friend, the business of a bookseller, on Chestnut Street, near Seventh, in Philadelphia, which was ultimately abandoned. A physical infirmity which afflicted him from birth, rendered

him averse to city life, and after declining business, he took on himself the care of the estate—the garden, especially, receiving his special attention. Physically strong, he loved to apply himself to garden work, and a large number of rare trees and plants were added from time to time, and set out with his own hands. Some of the finest specimens of the Japan cedar—*Cryptomeria Japonica*—are here, and the only known plant of the mammoth *Sequoia* in existence around Philadelphia. The tree, although not seeming to like our hot summers, is growing here in fair health—all from his planting and care. He would have disclaimed the title of botanist, but his love for trees and plants, and the great amount of knowledge he possessed regarding them, was very unusual in a mere lover of gardening. He always took great interest in the progress of natural history, and, in conversation with the writer, subjects connected with the Academy of Natural Sciences, showing an interest in its welfare, were frequent topics.

He continued his interest in the oversight of the family estate till about 1865, when it was divided, and he took his separate share. About this time he married a lady of Philadelphia with whom he had been long acquainted, and went to housekeeping on Girard Avenue, near Fairmount Park, in which beautiful spot, among the trees and flowers, he would spend most of his time. He died on the 30th of August, 1879, leaving the use of all he was possessed of to his wife during her lifetime, and to revert to the Academy on her decease.

NOVEMBER 3.

Mr. THOS. MEEHAN, Vice-President, in the chair.

Twenty-five persons present.

Virulence of the Common Parsnip.—Mr. MEEHAN referred to the deaths of some children, at Danville, Pa., in the spring of 1884, reputed to be caused by eating the roots of the wild parsnip. This was usually understood to mean the roots of *Cicuta maculata*, or perhaps *Conium maculatum*. Roots had been sent to him by the attendant physician, among which was the fragment of a portion that one of the dead children had partially eaten, with teeth marks on the remains. There seemed no chance for error in this case. The root, which was evidently neither of the two reputed to be virulent, was planted. It proved to be the true garden parsnip, *Pastinaca sativa*, which has become an escape from gardens in many parts of the United States. Although the evidence that the deaths were from the wild roots of the common garden parsnip appeared so conclusive, in view of the fact that there seems to be no record of such a virulent character in connection with this plant, it was thought possible there might still be some mistake, and corroborative evidence was sought for. It was found that in the cultivated form some growers are careful about weeding or working among the leaves while the dew is on them, as severe cases of poisoning have been known to result, and on large seed farms, the workmen engaged in cutting the stalks at the seed harvest, have to protect their hands and arms against contact with the juices, or they are liable to be severely poisoned in a manner similar to that from the poison vine *Rhus toxicodendron*. With these facts it seems worth placing on record what seems to be indisputable that the deaths of the Danville children were really caused by the wild garden parsnip, *Pastinaca sativa*.

NOVEMBER 10.

The President, Dr. LEIDY, in the chair.

Twenty-four persons present.

The Shape of the Hind Limb in the Mammalia as Modified by the Weight of the Trunk.—Dr. HARRISON ALLEN directed attention to the osseous characters of the posterior extremities in mammals, as determined by the weight borne. The shape of the hind limb in the majority of the forms is that best adapted for sustaining the weight of the hinder part of the trunk.

The head of the *femur* lies upon a neck which is relatively long;

the shaft is cylindroid, and the condylar
its diameters, but notably in its posterior
tion of the condyles made by extending
the posterior surface of the femur, the cond
in such manner as to retain in the rem
of the inter-condyloid notch. If, howeve
examined in the sloth, in the genus *Cyc*
arboreal ant-eater), in the bat and in the sea
is seen to be without a neck, or to possess
shaft of the femur is flattened, and the con
all expanded. If a section be made as ab
of the condyloid notch is not removed
bone in its general features resembles the

The *fibula* in the genera bearing the weig
two forms, one in which the bone is parallel
equal to it in length, and a second in which
anchylosed to the shaft of the tibia or is ob
which are suspended by the feet, or are o
sustenance of weight, the fibula, when it d
which it is separate from, but co-equal wi
reduced at the *proximal* end. In the se
anchylosed to the shaft of the tibia; in th
is entirely absent; in the sloth the proxi
small, while the distal end is broad and
function.

The *astragalus* is flattened and irregu
posterior extremities sustain weight, but i
weight it is elongated. The tendency
Tarsius, for both calcaneum and astragal
gated, but the tendency is carried to an
sloth, the bat, and in *Phoca vitulina*.

The manner of articulation in the gor
both the calcaneum and the astragalus, v
as the fact that the astragalus in that ge
deflected fibular facet. This peculiar proj
the astragalus of the skeleton of civilize
highly developed in an astragalus from an
Cooper's Point, New Jersey.

The following was ordered to be printe

ATTACK AND DEFENSE AS AGENTS IN ANIMAL EVOLUTION.

BY CHARLES MORRIS.

In considering the development of the dermal skeleton of animals, with its various modifications, we are led almost to the conception that nature has been controlled at successive periods by special ideas, each dominant during a long period, and then abandoned in favor of a new one. I have, in a previous communication to the Academy, advanced the hypothesis that in the primitive life era animals were destitute of hard parts, either external or internal, and that to this we must ascribe the lack of primitive fossils.

The development of an external skeleton, which seems to have long preceded that of an internal one, came like a new idea to nature, which was adopted almost simultaneously as it seems, though probably at considerable intervals, by the various types of life. We are quite sure that the first appearance of fossils in the rocks does not indicate the first appearance of life upon the earth. Early fossilization is due to the preservation of the dermal skeletons of animals of considerably advanced organization, and these were very probably preceded, during a long era, by soft-bodied forms of low organization. These could leave no trace of their existence, except in the case of the burrowing worms, or of impressions made by animal forms on beds of mud or other plastic material. Yet after the advent of armored animals, it is probable that the seas were still tenanted by numerous soft-bodied forms, mainly swimmers, the progenitors of the many naked ocean swimmers which still exist.

The earliest armored forms were principally surface dwellers, or sluggish swimmers. Swift-swimming armored animals came in with the fishes, and these increased in thickness and weight of armor to the end of the Devonian era. During this period all the higher forms of life seem to have acquired more or less dense dermal armor. Their agility must have been much reduced by the weight and rigidity of this armor. None but the fishes were active swimmers, and most of the armored animals were surface-dwellers.

If now we come down to a later era of life, we find in operation what seems a third idea of nature. The prevailing tendency in

animal life is no longer to assume armor, but to throw off armor, and return towards the unprotected condition. This tendency was quite as marked in its operation as the others, as a hasty review will show.

In the antique type of vertebrate life, the fish, the thick armor of the primeval era has been in great part replaced by the thin scales of the Teleosteans. The Ganoids have nearly vanished. Many Elasmobranchs yet exist, but their armor never gained the dense and rigid character of the Ganoid scales. But the loss of the old condition is more particularly shown in the new forms of life. The Labyrinthodont amphibians were clothed in armor, their heads in particular being protected by hard bony plates. Modern amphibians are naked-skinned animals. The reptiles are usually scaled, but, with the exception of the crocodiles and turtles, and some few fossil types, do not seem to have ever been clothed in bony armor. In the later vertebrate classes, the birds and mammals, all defensive armor is lost, the covering of hairs and feathers being protective only against cold. Finally, in the human species, even the covering of hairs is nearly lost, and in external condition the highest form of animal life approaches the lowest.

A like tendency to pass from the armored to the unarmored condition appears in invertebrate life. In most of the invertebrates the dermal covering serves as a basis of muscular attachment, and cannot be dispensed with. The soft-bodied invertebrates of low orders, such as the worms, the medusæ, etc., are probably survivals of the primitive life condition, and may indicate the general character of pre-Cambrian life. But in the higher mollusks a very interesting variation appears. The Palæozoic cephalopods were all covered with a dense protective armor. In the Mezozoic period this class began to give way to an unarmored class, with a change in the character of its muscular attachment. To the tetrabranchiates, with muscles attached to the external shell, were added the dibranchiates, with naked surface, and an internal basis of muscular attachment. Since that period the evolutionary process has been highly interesting. The armored cephalopods have gradually disappeared, until only the Nautilus remains. The unarmored forms have rapidly increased, until they abundantly people the modern seas.

The process of modification I have here briefly indicated has

another interesting feature, which may be pointed out. This is that the modification has not taken place by a simple change in the dermal structure of existing types, but that this change has been accompanied by a radical change in organic structure. The representatives of the old forms have retained much of their old surface structure. The radical variation in surface condition has been confined to new types of life.

In the case of the primitive soft-bodied animals, for instance, they have probably had representative forms throughout the whole era of life, and may be closely simulated by the soft-bodied ocean animals yet existing. The assumption of armor by certain forms was probably accompanied by a marked change in structure, the dermal variation being co-related with other important changes. Of this, of course, we cannot be sure, but in the parallel case of the discarding of armor this idea holds good. The Ganoids continue armored fishes to the present day. The prevailing thin-scaled fishes are of a new structural type. In the cephalopods we do not find a simple discarding of shells by the armored type, but the gradual disappearance of this type, and its replacement by a type of markedly different structure. In the vertebrata generally the antique types have preserved the scaled condition to a greater or less extent. It is in the new structural types, the birds and mammals, that this antique condition has been most fully discarded, and replaced by a radically distinct dermal covering. It would almost seem as if it had been impossible for any type of animal to completely dispense with a primitive structural feature except under the influence of a general organic change. In the assumption of armor the whole organic structure may have suffered a correlated change. In the discarding of armor a like radical change in structure has taken place, while the representatives of the ancient types have preserved their ancient dermal conditions.

I present these simply as a series of well-known facts. It is with the cause of these facts that I am mainly concerned. Why did animal life exist for a long period without protective covering; then adopt armor of defense, and develop it to an extraordinary degree; and finally slowly discard this armor, and return towards the unprotected condition? We have here a remarkable series of evolutionary changes. They undoubtedly had sufficient and powerful causes. What were those causes?

These we need not go far to seek. The
The variations described have taken place
one of the most active and efficient agen
the reciprocal influence of attack and defen
To this agent in animal change there has n
attention as it demands. It is, indeed, but
agents which act to modify animal form
among these agents it has been one of the
and unceasing.

The effort of food animals to escape from
given rise to a great variety of defensive
habits. It has aided in the natural selectio
kinds, of defensive weapons, of speed and
of size and strength of body, of cunning
many other characteristics, each of evo
And the study of animal development go
varied conditions have been assumed succ
apparently fully worked out the capabil
defense before proceeding to another.

The effort to capture and destroy food an
important as an agent in evolution. It h
selection of weapons of offense, such as
strength, swiftness, agility, alertness, cunn
butes of mind and body, together with man
which form steps in evolution. The main
has been the reciprocal action of these agen
gained some structural feature which gav
its carnivorous foes, the latter would be a
they had gained equivalent features. So t
gained some habit, motion or weapon which
in destroying, this must have acted as an
sponding development in food animals. N
both cases, preserved the forms best adap
tions of attack or defense, and the carnivo
in a metaphorical sense, pursued each ot
evolution.

In this process now one class, now the
the lead. If at any time the two classes w
powers of attack and defense, any new pow
in the food animals would undoubtedly be

selection. It would give them an advantage in the struggle for existence, which could not be overcome until the carnivora had gained a correlated development. On the other hand any new offensive weapon or method would give the carnivora an advantage, which would render necessary some new defensive adaptation in food animals.

In this process of evolution we find several instances in which defensive appliances seem to have gained a special development, which were only slowly met by new methods of attack. Such I conceive to have been the case when the power of secretion of dermal armor was once attained, and to the high value of this defensive expedient I ascribe its rapid development. According to my theory of the case the preceding animals had been naked skinned, and the destructive weapons of the carnivora such as were adapted to the capture of soft-bodied prey. There is not a shred of evidence that any toothed forms existed preceding or during the Cambrian era, nor until well on in the Silurian. Yet toothless animals could not easily overcome animals with a strong covering of bone or other hard material. It is to this fact that I ascribe the rapid increase in number and variety of armored forms. Their armor gave them a special advantage in defense, and under this idea there is no difficulty in understanding the very rapid and general evolution of this structural feature of animal life.

In fact, as a result of the development of defensive armor, a discrepancy arose between the agencies of attack and defense. Defense had the best of it. A structural feature had been rapidly acquired, which could only be met by some corresponding new means of attack, and this new carnivorous weapon took a long time to develop.

The new weapon, through whose aid the aggressive again slowly matched the defensive appliances, made its appearance in the form of the tooth. It but slowly grew effective. The first evidence we find of teeth are the minute *conodonts*, which may or may not have had this function. Fish teeth at first appear in small and weak forms, but they gradually grow large and powerful, and well adapted for cutting and crushing. A race between aggressive and defensive powers apparently took place. Armor grew thicker and denser as teeth became more efficient. As one result of the race we have the great Devonian fishes, with their

powerful armor and teeth. The toothless invertebrates probably still fed on small, unarmored prey.

In all cases, however, the most powerful animals would have little or no need of defensive armor. The armed Ganoids probably needed defense against each other. But it is likely that they were mainly defended against the great Elasmobranchs, which were the ruling tyrants of the seas, and which needed no defense beyond their osseous tubercles and spines, this type of armor permitting the utmost flexibility of motion. As Packard says of them: "Sharks and skates are engines of destruction, having been, since their early appearance in the upper Silurian age, the terror of the seas. Their entire structure is such as to enable them to seize, crush, tear and rapidly digest large invertebrates, and the larger marine members of their own class. Hence their own forms are gigantic, soft, not protected by scales or armor, as they have in the adult form few enemies." Such seems to have been the outcome of the agencies of attack and defense in the palæozoic era, a minor series of soft-bodied animals, an intermediate series of strongly armored animals, and a superior series of animals, adapted to break through the strongest defensive armor.

As a result of this evolutionary process the powers of assault and defense again became equalized, and armor lost its special value as a defensive agent. From that time forward defense seems to have adopted a new expedient, and a fresh series of modifications arose. If armor had become of little value in defense, flight remained useful. But armor impeded flight, both from its weight and the rigidity of body it produced. Thus for the development of speed, agility and flexibility of motion, it was necessary to get rid of armor; and during the whole of the later geological periods this has been the character of the evolutionary process, at least in the free-moving animals. Food animals have thrown off their armor, and trusted to speed and flexibility of motion for safety. Carnivorous animals have followed in the same direction, and got rid of their disabling armor.

If we pursue this subject further we can perceive the successive adoption of several other expedients. It is impossible to say whether flight or pursuit first aided in the development of winged animals. But it is evident that flying food animals would be nearly safe from the attacks of surface carnivora, and would

gain a security which only the development of flying carnivora could overcome. The same may be said of tree-living and burrowing animals. It seems highly probable that all these expedients were first adopted in the effort to escape destruction, and that similar expedients were afterwards adopted by carnivora in their pursuit of prey. It would not be safe to declare that the various expedients mentioned were in every case first adopted by food animals, and afterwards by the pursuing carnivora, but the probability is that this was the case as a general rule.

I may briefly refer to one other and a highly important result of this evolutionary process. When powers of flight had become balanced by powers of pursuit, it is evident that this expedient, like that of armor, had lost its special utility. As a result another and final expedient began a special development. Cunning and shrewdness came into play as aids in escape. The mental powers of animals began to strongly unfold. This was the case in both classes of animals, and it is impossible to say which took the lead. In both classes cunning, concealment, reasoning powers, came into play, and blind flight and pursuit, or defense through sheer bulk and strength, became succeeded, in many cases, by the higher and more efficient agency of the mind. Instinct became less dominant in animal life; reason more dominant. In other words, the mind grew more active and varied in its operations.

The growth of this most recent animal modification is manifest in the character of the later geological life. The development of the brain becomes marked as we enter the tertiary era, and the capacity of the brain cavity steadily increases throughout this era. What is called cephalization is the most important characteristic of animal development throughout the tertiary age. In the recent era this has reached its culmination, and mental expedients have replaced physical conditions in the highest life types as the most efficient agencies of attack and defense.

Thus we seem to perceive four successive ideas emerging into prominence in the development of the animal kingdom. In the primeval epoch it is probable that only soft-bodied animals existed, and the weapons of assault were the tentacle, the thread cell, the sucking disk, and the like unindurated weapons. At a later period armor became generally adopted for defense, and the tooth became the most efficient weapon of attack. Still later armor was discarded, and flight or concealment became the

main methods of escape, and swift pursuit the principle of attack, while claws were added to teeth as assailing weapons. Finally mentality came into play, intelligence became the most efficient agent both in attack and defense, and a special development of the mind began. As a culmination of the whole, we have man, in whom mentality has replaced all other agents in the struggle for existence. But side by side with man all the other types exist, the soft-bodied, the armored, the swift-moving, and those in which cunning precedes the higher mentality. In the existing conditions of life upon the earth we have an epitome of the whole long course of evolution.

November 17.

Mr. Thos. Meehan, Vice-President, in the chair.

Thirty-two persons present.

The deaths of Wm. G. Platt, a member, and of Wm. B. Carpenter, a correspondent, were announced.

November 24.

The President, Dr. Leidy, in the chair.

Twenty-two persons present.

A paper entitled "Notes on the Lafayette Serpentine Belt," by Theo. D. Rand, was presented for publication through the Mineralogical Section.

The following were elected members:

John H. Campbell, W. G. A. Bonwill, M. D., Chas. S. Dolley, M. D., Chas. N. Davis and Wm. D. Averell.

The following was ordered to be printed:

A REVIEW OF THE AMERICAN SPECIES OF THE GENUS SCORPÆNA.

BY SETH E. MEEK AND ROBERT NEWLAND.

In the present paper is given the synonymy of the American species of the genus *Scorpæna*, with an analytical key, by which the species may be recognized. For purposes of comparison, the two European species are included in the key and their synonymy is given in part. *Scorpæna dactyloptera* is not included in this analysis, as with Dr. Gill, we refer it to a distinct genus *Sebastoplus*.

The specimens examined by us all belong to the museum of the Indiana University, most of them having been collected by Professor Jordan. To Professor Jordan we are under many obligations in connection with our study of this and other groups of fishes.

Genus SCORPÆNA, Linnæus.

Scorpæna, Artedi, Genera Piscium, 1738, 47.
Scorpæna, Linnæus, Systema Naturæ, 1766, 452 (*porcus*).
Pontinus, Poey, Memorias Cuba, ii, 1860, 173 (*castor*).
Sebastapistes, (Gill) Streets, Bull. U. S. Nat. Mus. vii, 1877, 62 (*guttata; strongia; cyanostigma*).

Analysis of Species of Scorpæna.

a. Occiput with a distinct quadrate pit, about as large as eye.

b. Breast not scaly; second anal spine decidedly stronger than the third; coronal spines present.

c. Scales rather large, thin, most of them with dermal flaps; about 40 scales in lateral line; a small distinct pit between the lower anterior margin of orbit and suborbital stay; dorsal fin high, its longest spine $1\frac{4}{5}$ to 2 in head; longest anal spine $3\frac{1}{5}$ in head; eye small, $4\frac{3}{4}$ to 5 in length of head; supraocular tentacles less than the diameter of eye; pit at occiput rather shallow, nearly square. Head $2\frac{1}{3}$; depth 3; D. XII–10; A. III–5. Axil dusky with no distinct spots. Fins all whitish, marbled with darker; irregular dark markings on sides. *Scrofa*. 1.

cc. Scales small, firm, a few below the lateral line with dermal flaps. About 65 scales in the lateral line; no distinct pit between the lower anterior margin of the orbit and

suborbital stay; dorsal fin lower, its longest spine $2\frac{1}{4}$ in head; anal spine $2\frac{1}{4}$ in head. Eye larger, $4\frac{1}{4}$ in head. Supraocular tentacles about as long as diameter of eye. Head $2\frac{1}{2}$; depth $2\frac{2}{3}$; D. XII–10; A. III–5. Axil dusky, with one or more dark spots. Body brownish red, marbled with darker, and dotted with deep black, which sometimes forms edges around the darker spots. *Porcus.* 2.

bb. Breast scaly.

d. Coronal spines present; supraocular tentacles about equal to diameter of eye.

e. Third anal spine evidently longer and stronger than the second; suborbital stay armed with three spines; no distinct pit between lower anterior margin of orbit and suborbital stay; length of second anal spine $2\frac{1}{2}$ (young) to 3 (adult) in head; longest dorsal spine $2\frac{1}{6}$ in head. Head $2\frac{1}{2}$; depth $2\frac{2}{3}$; scales in lateral line about 48; some of the scales with dermal flaps. D. XII–10; A. III–5. Supraocular tentacles less than diameter of eye; axil dusky, with small round brownish spots. Color brownish, clouded with darker; a few darker dots behind pectorals. *Brasiliensis.* 3.

ee. Third anal spine shorter and weaker than second.

f. Suborbital stay not armed with spines; occipital pit evidently broader than long.

g. Cheeks scaly; fins low; longest dorsal spine $2\frac{1}{2}$ to 3 in head; no distinct pit between lower anterior margin of orbit and suborbital stay.

h. Scales large, some of them with dermal flaps; about 30 in the lateral line; supraorbital tentacles well developed. Head $2\frac{1}{10}$; depth $3\frac{1}{6}$; D. XII–10; A. III–5; longest dorsal spine 3 in head; longest anal spine 3 in head; eye $4\frac{1}{2}$ in head. Color gray or red, with broad, darker shades, irregular and variable; fins similarly colored; pectorals barred (*Günther.*) *Histrio.* 4.

hh. [1] [Scales smaller, without dermal flaps; about 46 scales in the lateral line. Head $2\frac{3}{4}$; depth $3\frac{2}{3}$; eye $3\frac{3}{4}$ in head; longest dorsal spine $2\frac{1}{2}$ in head; longest

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[1] These characters are taken from Valenciennes figure, and are all more or less doubtful.

anal spine 2½ in head. D. XII–10; A. III–5. Head chiefly red; red markings on dorsal fin and on back; pectoral fins barred.] *Fucata.* 5.

gg. Cheeks not evidently scaly; fins higher; longest dorsal spine 2 in head; a distinct pit between lower anterior margin of orbit and suborbital stay; scales smaller; about 50 in the lateral line; no dermal flaps except along the lateral line, where they are small; supraorbital tentacles small; about ½ diameter of eye. Head 2½; depth 3¼; eye 4½ in head; axil dusky, with round brownish spots on its upper part; body with many round brownish-black spots, some of which are nearly as large as eye. *Guttata.* 6.

ff. Suborbital stay armed with three or four spines; occipital pit about as long as broad.

i. No distinct pit between lower anterior margin of orbit and suborbital stay. Head entirely naked; supraorbital tentacles little developed, less than diameter of eye; a few scales with dermal flaps, lateral line with 42 scales.

Head 2½; depth 2⅔; D. XII–10; A. III–5. Longest dorsal spine 2½ in head; longest anal spine 2⅓ in head; eye 5 in head.

Reddish, marbled with darker, all of the fins light colored, scantily spotted (*Günther*).

Thompsoni. 7.

ii. A distinct pit between lower anterior margin of orbit and suborbital stay; upper parts of opercle scaly; supraorbital tentacles well developed, longer than eye; most of the scales provided with dermal flaps: lateral line with 30 scales. Head 2⅔; depth 3; D. XII–10; A. III–5. Longest dorsal spine 2⅔ in head; axil of pectoral black with few white spots; olive-brown, excessively marbled with silvery and reddish; fins profusely variegated; caudal barred with brown and silvery; a dark blotch on spinous dorsal between the sixth and seventh spines.

Plumieri. 8.

dd. Coronal spines absent. Supraocular tentacles high, more than twice the diameter of the eye; occipital pit rather

deep; longest dorsal spine 2¼ in length of head; head 2½; depth 2¾. About 38 scales in the lateral line; eye 4 in head; dermal flaps on lateral line longer than eye, a few of the scales on upper and posterior parts of the body with dermal flaps. Suborbital stay with a small spine near its centre, one on its posterior end; axil dusky, with small white dots on its upper portion; color reddish, marbled with brown. Head and body minutely dotted with white; caudal and anal fins with broad white bands. *Grandicornis*. 9.

aa. Occiput without evident pit; no pit between lower anterior margin of orbit and suborbital stay; cheeks scaly.

j. Pectoral rays all simple; opercle and subopercle well scaled; occipital pit obsolete; dermal flaps on scales of the lateral line and belly. Supraorbital tentacles not branched, $\frac{1}{8}$ the length of the body. Second anal spine moderate; spinous dorsal low, D. XII–10; A. III–5. Color uniform carmine-red, the fins somewhat clouded with orange. Supraorbital tentacle and lower pectoral with brown bands. Head 2¼ total length; eye 5 in head. *Castor*. 10.

jj. Pectorals with some of their upper rays branched.

k. Scales large, about 28 in the lateral line; occipital cavity almost obsolete; longest dorsal spine 2⅗ in head; longest anal spine 3 in head; second and third anal spines subequal; few of the scales with dermal flaps. Eye about 3½ in head. Suborbital stay armed with two small spines; supraocular flaps minute, a few small flaps on the head; depth of body 3 in length. Color dusky grayish, marbled with blackish; a black suborbital bar; a black bar at base of caudal; axil of pectoral whitish with dusky specks, a black spot on its upper edge; ventrals mostly black (*Goode and Bean*). *Occipitalis*. 11.

kk. Scales small, about 47 in the lateral line; longest dorsal spine 2¼ in head; longest anal spine 1⅗ in head; second anal spine evidently longer and stronger than the third. Head 2⅗; depth 3; eye

4 in head. Sides of bod
brown marmorations ; a l
of spinous dorsal betwee
spines. Supraorbital ten
dachner).

1. **Scorpæna scrofa.**

Scorpæna scrofa Linnæus, Systema Natur
terranean Sea); Gmelin, Systema Nat
nean); Turton's Linnæus, Systema Natur
Lacépède, Hist. Nat. Poiss., iii, 1800, 2
Systema Ichthyol., 1801, 193 (Atlant
Ichth. Nice, 1810, 186 (Nice); Cuvier
Poiss., iv, 1829, 293 (Mediterranean);
Mus., ii, 1860, 109 (Mediterranean; Malt
Lisbon ; River Niger ; Azores ; Madeira);
& Berichte, iv, 1867, 75 ; (Barcelona ; T
Gibraltar ; La Coruña ; Vigo ; Lisbon ;
Proc. U. S. Nat. Mus., 1879, 23 (Gibralta
Scorpæna barbata Lacépède, Hist. Nat. Po
Scorpæna lutea Risso, Ichth. Nice, 1810, 1
? *Scorpæna ustulata* Lowe, Proc. Zoöl.
Günther, Cat. Fish. Brit. Mus., 1860, 11

Habitat.—Mediterranean Sea and the a
The numerous specimens of *Scorpæna*
were collected at Venice by Dr. Jordan.

2. **Scorpæna porcus.**

Scorpæna porcus Linnæus, Systema Natu
terranean) ; Linnæus, Systema Natura,
Turton's Linnæus, Systema Natura, 1
Bloch & Schneider, Systema Ichthyol., 1
Atlantic); Risso, Ichthyol. Nice, 1810, 1
ciennes, Hist. Nat. Poiss., iv, 1829, 30
Caen ; New York ??); DeKay, N. Y. Fa
Günther, Cat. Fish. Brit. Mus., ii, 1860
matia ; Adriatic ; Bay of Naples ; Lisbon
Ichth. Notizen und Berichte, 1867, 7
Valencia ; Alicante ; Malaga ; Cartagena ;
Lisbon ; La Coruña ; Vigo ; Algorta ; Sa
Proc. U. S. Nat. Mus., 1879, 23 (Constant
& Gilbert, Syn. Fish. N. A., 1883, 68 (S
Cottus massiliensis Forskal, Desc. Animal,
Scorpæna massiliensis Lacépède, Hist. Nat.
seilles); Cuvier & Valenciennes, Hist. N

Habitat.—Mediterranean Sea and adjacent Atlantic. The locality "New York," given by Cuvier and Valenciennes, is doubtless an error.

The numerous specimens examined by us are from the market of Venice.

3. **Scorpæna brasiliensis.**

Scorpæna brasiliensis Cuvier & Valenciennes, Hist. Nat. Poiss., iv, 1829, 305 (Brazil); Günther, Cat. Fish. Brit. Mus., ii, 1860, 112 (South America; Rio Janeiro; Bahia); Kner, Novara Fische., 1865, 114 (Rio Janeiro); Jordan, Cat. Fish. N. A., 1885, 109.

Scorpæna stearnsi Goode & Bean, Proc. U. S. Nat. Mus., 1882, 236 (Gulf of Mexico); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 421 (Pensacola); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 614 (Charleston); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 620 (Charleston); Jordan & Gilbert, Syn. Fish. N. A., 1883, 951; Jordan, Proc. Acad. Nat. Sci., Phila., 1884, 45 (Egmont Key).

Habitat.—Atlantic coast of America from Charleston to Rio Janeiro.

The specimens of this species examined by us are from Key West and Pensacola, Florida.

There seems to be no serious reason to doubt that *Scorpæna brasiliensis* is identical with the species known on our coast as *Scorpæna stearnsi.*

4. **Scorpæna histrio.**

Scorpæna histrio Jenyns, Zoöl. Voy. Beagle, Fishes, 1842, 35, pl. 8 (Chatham Island: Galapagos Archipelago); Günther, Cat. Fish. Brit. Mus., ii, 1860, 115 (copied); Steindachner, Ichthyol. Beiträge, ii, 1875, 8 (Juan Fernandez); Jordan, Proc. Acad. Nat. Sci. Phila., 1883, 292 (Chinchas Islands).

? *Scorpæna fucata* Valenciennes, "Voy. Venus, v, Zoöl., 1855, 313, Pl. 3, fig. 2" (Galapagos Archipelago).

Habitat.—Chatham Island; Galapagos Archipelago.

The figure of *Scorpæna fucata* differs in only a few minor characters from *S. histrio*, and was probably intended for that species. The differences may be due to the mistakes on the part of the artist employed by Valenciennes.

5. **Scorpæna guttata.**

Scorpæna guttata Girard, Proc. Acad. Nat. Sci. Phila., 1854, 145 (Monterey); Girard, U. S. Pac. R. R. Surv., 1859, 77, Pl. 17 (Monterey): Jordan & Gilbert, Proc. U. S. Nat. Mus., 1880, 455 (Santa Barbara; San Pedro; San Diego); Jordan & Jouy, Proc. U. S. Nat.

Mus., 1881, 6 (Wilmington, California; Santa Catalina; San Pedro; Santa Barbara); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 278 (Ascension Islands; West Coast of Lower California); Jordan & Gilbert, Syn. Fish. N. A., 1883, 679; Jordan, Cat. Fish. N. A., 1885, 109.

Sebastopistes guttata (Gill) Streets, Bull. U. S. Nat. Mus., vii, 1877, 62 (generic diagnosis).

Habitat.—Coast of California, from Point Conception southward to Cerros Island.

We have examined two specimens of this species, both from Southern California.

6. **Scorpæna Thompsoni.**

Scorpæna thompsoni Günther, Voyage of the Challenger, Fishes, 1880, 24, pl. xii (Juan Fernandez).

Habitat.—Juan Fernandez.

This species is known only from Günther's description and figure.

7. **Scorpæna plumieri.**

Rascacio Parra, Dif. Piezas Je' Hist. Nat., 1787, 24, pl. 18, fig. 9 (Havana).

Scorpæna plumieri Bloch, Kon. Vet. Acad. Nya. Hand'gr. Stockholm, x, 1789, 234 (Martinique; on a drawing by Plumier); Bloch & Schneider, Systema Ichthyol., 1801, 194 (Antilles; Günther, Cat. Fish. Brit. Mus., ii, 1860, 113 (Jamaica; West Indies; South America; Kner, Novara Fische, 1866, 114 (Rio Janeiro; Jordan & Gilbert, Bull. U. S. Fish. Comm., 1882, 108 (Mazatlan; Jordan & Gilbert, Bull. U. S. Fish. Comm., 1882, 111 (Panama); Goode & Bean, Proc. U. S. Nat. Mus., 1882, 235 (Gulf of Mexico); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 377 (Panama; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 627 (Panama; Jordan & Gilbert, Syn. Fish. N. A. 1883, 680 (Mazatlan; Jordan, Proc. U. S. Nat. Mus., 1884, 137 Key West; Jordan, Cat. Fish. N. A., 1885, 109.

Scorpæna bufo Cuvier & Valenciennes, Hist. Nat. Poiss., iv, 1829, 306 (Martinique; Brazil; Richardson, "Fauna Bor. Amer. Fishes, 1839, 300"; Newfoundland, by error for Florida.

Scorpæna bufo De Kay, N. Y. Fauna Fishes, 1842, 59, pl. 70, fig. 227 (copied).

Scorpæna rascacio Poey, Memorias Cuba, ii, 1860, 169 (Havana; Poey, Syn. Pisc. Cub., 1868, 303 (Havana; Poey, Enum. Pisc. Cub., 1875, 40 (Havana; Castelnau, "Anim. nouv. ou rares. Amer. Sud. Poiss. 1861, 7."

? *Scorpæna scrofina* Cuvier & Valenciennes, Hist. Nat. Poiss., 1843, 465 (Brazil).

Apistes [illegible] Gosse, "Natur. Soj. Jamaica, 1856, 207" Jamaica.

Habitat.—West Indies; Atlantic and Pacific Coasts of Tropical America, north to Florida.

This species was studied from specimens varying in length from three to eight inches, collected at Havana and Key West, by Dr. Jordan.

The species may be known at once by the coloration of the pectoral axil, which is jet black, with large white spots.

Below is given a table of measurements of three specimens from Key West. The proportions are given in hundredths of length from tip of snout to the end of last vertebra:

Extreme length of fish in inches,	8	7½	4⅕
Length of fish from end of snout to last caudal vertebra, in inches,	6	5¾	8⅕
Greatest depth of fish (hundredths of the above),	84	34	35½
Greatest width of body,	28	32½	26
Length of head,	45	48½	46½
Length of maxillary,	22	23½	22½
Distance from snout to orbit,	13	13	13
Diameter of orbit,	9	10	11
Height of highest dorsal spine,	16	18	19½
Height of highest dorsal ray,	18	16	
Length of pectoral,	36	37½	34
Width of pectoral base,	19	17	18
Length of ventrals,	31	31	30
Height of second anal spine,	20½	21½	26½
Height of third anal spine,	18½	19	21

8. **Scorpæna grandicornis.**

Scorpæna grandicornis Cuvier & Valenciennes, Hist. Nat. Poiss., iv, 1829, 309 (Martinique; Porto Rico; Havana; San Domingo); Günther, Cat. Fish. Brit. Mus., ii, 1860, 114 (Jamaica); Poey, Syn. Pisc. Cub., 1868, 303 (Havana); Poey, Enum. Pisc. Cub., 1875, 40 (Havana); Jordan, Proc. U. S. Nat. Mus., 1884, 138 (Key West); Jordan, Cat. Fish. N. A., 1885, 109.

Scorpæna plumieri Lacépède, Hist. Nat. Poiss., ii, 1800, 282, pl. 19, f. 3 (not of Bloch and Schneider, based on a drawing by Plumier; Martinique).

Habitat.—West Indies, Florida Keys to Brazil.

Our study of this species was made from numerous small specimens. none exceeding five inches in length, collected at Key West by Dr. Jordan, and from a large example taken at Havana.

The species may be readily distinguished by the absence of coronal spines, by the great size of the supraocular tentacles, and by the small white spots in the pectoral axil.

Below is given a table of measurements of three specimens of *Scorpæna grandicornis* from Key West. The proportions are given in hundredths of the length from tip of snout to end of last vertebra.

Extreme length of fish, in inches,	4½	4½	2
Length of fish from end of snout to last caudal vertebra, in inches,	3½	3½	1½
Greatest depth of body (hundredths of the above),	40½	43	40
Greatest width of body,	21	22	22
Length of head,	42½	42½	43
Length of maxillary,	20	19½	20
Distance of snout from orbit,	9½	9½	10
Diameter of orbit,	10½	11	12
Height of highest dorsal spine,	21	19½	22
Height of longest dorsal ray,	19½	20	17
Height of second anal spine,	23	21	24
Height of third anal spine,	20	20	20½
Length of pectoral fin,	35½	34	33
Width of base of pectoral,	20	15½	15
Length of ventrals,	28	29	33½

9. **Scorpæna castor.**

Pontinus castor Poey, Memorias Cuba, ii, 1860, 173 (Havana); Poey, Syn. Pisc Cub., 1868, 303 (Havana); Poey, Enumeratio Pisc., Cub., 1875, 4 (Havana).

? *Pontinus pollux* Poey, Memorias Cuba, ii, 1860, 174 (Havana); Poey, Syn. Pisc. Cub., 1868, 300 (Havana); Poey, Enumeratio Pisc. Cub., 1875, 4 (Havana).

Habitat.—Havana.

We know this species only from the descriptions of Professor Poey.

The genus *Pontinus* seems to be synonymous with *Scorpæna*. From Poey's description of *Pontinus pollux*, we are unable to find any positive characters by which to distinguish it as a species from *Scorpæna castor*.

10. **Scorpæna fernandeziana.**

Scorpæna fernandeziana Steindachner, Ichthyol. Beiträge, ii, 1875, 9 (Juan Fernandez).

Habitat.—Juan Fernandez.

This species is known only from Steindachner's description.

11. **Scorpæna occipitalis.**

? *Scorpæna inermis* Cuvier & Valenciennes, Hist. Nat. Poiss., iv, 1829, 311 (Martinique).

Scorpæna occipitalis Poey, Memorias Cuba, ii, 1860, 171 (Havana); Poey, Syn. Pisc. Cub., 1868, 303 (Havana); Poey, Enumeratio, Pisc. Cub., 1875, 41 (Havana); Jordan, Cat. Fish. N. A., 1885, 109.

Scorpæna calcarata Goode & Bean, Proc. U. S. Nat. Mus., 1882, 422 (Clear Water Harbor, Florida); Jordan & Gilbert, Syn. Fish. N. A., 1883, 952 (West Coast of Florida).

Habitat.—Havana; West Coast of Florida.

On comparison of Poey's description of *S. occipitalis*, with the description *S. calcarata* by Goode and Bean, we can find nothing by which to distinguish them as distinct species.

Scorpæna inermis, very briefly described by Cuvier and Valenciennes, resembles this species more than any other.

The following is a list of the nominal species referred to in the foregoing paper, arranged in chronological order, with our identification of each. Tenable specific names are printed in italics:—

Nominal Species.	*Year.*	*Identification.*
Scorpæna *porcus* Linnæus,	1758,	Scorpæna porcus.
Scorpæna *scrofa* Linnæus,	1766,	Scorpæna scrofa.
Cottus massilensis Forskal,	1775,	Scorpæna porcus.
Scorpæna *plumieri* Bloch,	1789,	Scorpæna plumieri.
Scorpæna barbata Lacépède,	1800,	Scorpæna scrofa.
Scorpæna plumieri Lacépède,	1800,	Scorpæna grandicornis.
Scorpæna lutea Risso,	1810,	Scorpæna scrofa.
Scorpæna *brasiliensis* Cuv. & Val.,	1829,	Scorpæna brasiliensis.
Scorpæna bufo. Cuv. & Val.,	1829,	Scorpæna plumieri.
Scorpæna *grandicornis* Cuv. & Val.	1829,	Scorpæna grandicornis.
Scorpæna inermis Cuv. and Val.,	1829,	? Scorpæna occipitalis.
Scorpæna scrofina Cuv. & Val.,	1833,	Scorpæna plumieri.
Scorpæna ustulata Lowe,	1840,	? Scorpæna scrofa.
Scorpæna *histrio* Jenyns,	1842,	Scorpæna histrio.
Scorpæna *guttata* Girard,	1854,	Scorpæna guttata.
Scorpæna fucata Valenciennes,	1855,	? Scorpæna histrio.
Apistes exul Gosse,	1856,	Scorpæna plumieri.
Scorpæna rascacio Poey,	1860,	Scorpæna plumieri.
Scorpæna *occipitalis* Poey,	1860,	Scorpæna occipitalis.
Scorpæna *fernandeziana* Steindachner,	1875,	Scorpæna fernandeziana.
Pontinus *castor* Poey,	1875,	Scorpæna castor.
Pontinus pollux Poey,	1875,	? Scorpæna castor.
Scorpæna *thompsoni* Günther,	1880,	Scorpæna thompsoni.
Scorpæna stearnsi Goode & Bean,	1882,	Scorpæna brasiliensis.
Scorpæna calcarata Goode & Bean,	1882,	Scorpæna occipitalis.

December 1.

The President, Dr. Leidy, in the chair.

Thirty-eight persons present.

On a white-seeded variety of the Honey Locust.—Mr. Thomas Meehan exhibited seeds of a tree of the Honey Locust, *Gleditschia triacanthos*, growing near Germantown, which were white instead of dark olive-brown as in the normal condition. The tree was of considerable age, and had evidently been bearing fruit for many years. He had had, he said, many opportunities of examining Honey Locust seeds, but had never seen or heard of a white seeded one before. The seeds instead of being narrowly ovate twice the length of the breadth as usual, were nearly orbicular, illustrating a point not new but worth emphasizing, that when a plant varied from its parent in any one respect, it was liable to have variations in others. A whole system of variations followed a single departure. But the best use of this departure was to illustrate a point not yet perceived in its full force, as he believed, that variation is not nearly as much dependent on environment as many eminent men believe. When variations occur it is difficult for some to believe that cross-fertilization, a return to some characteristic of an ancient parent, or some accident of climate or soil had not an agency in the change. In cases such as this, where there was no other shade of color to cross with, no known progenitor with any variation in the color of the seeds, no accident of climate or soil to influence this one tree more than others growing near, it was difficult to understand how anything as yet suggested could be a factor in the change. We have to use yet the indefinite and meaningless expression that the change was caused by the plant's own innate power to change, an expression, which, obscure as it might be, is yet of service by excluding much from the examination that might add to the complexity of the investigation.

Another interesting suggestion from these seeds was the hereditary power which a new variation possessed. There had been no time to ascertain whether these seeds would again reproduce trees with white seeds; but by analogy drawn from similar departures in other plants, there is no doubt the reproduction of the variety would be as continuous as in the best recognized species.

It could hardly be supposed that since the first appearance of the Honey Locust on the earth, this was the first time the tree had ever produced white seeds, though he had never seen one or knew of any recorded instance. In view of the hereditary character of these variations, it might be asked why has not some

early white departure perpetuated and propagated itself so that such trees should be quite common in this era? The different abilities of various classes of plants to propagate themselves were pointed out. Of small seeds produced by such a plant as chickweed, hundreds get the chance to grow. Perennial plants, such as Aster, Golden Rods, also, in a general way, had great facilities for seed germination, hence any departure from a parental form had a good chance to perpetuate itself, the only great enemy being the struggle of the young living plants to get a portion of the nutrition necessary for life. Hence we had many variations among such genera very puzzling to naturalists, running the species together so that it was only with great difficulty the species of some genera could be classified. Among trees with larger seeds it was difficult to perpetuate the race, and it was providential in many cases that longevity was great, or the race would soon have become extinct. Of the hundreds of thousands of Acorns, Chestnuts, Beechnuts, and other similar seed produced in a forest in any one season, only a few score would get a chance to grow up to produce seeds again. Birds, quadrupeds, and insects ate the seeds by thousands, large numbers could not sprout for want of a proper covering of earth. Of those which sprouted, numerous were they that failed to get beyond the first year; and of these, shade, or the innumerable struggles they were subjected to, permitted them not to reach mature age. He had known Honey Locust trees, single specimens, bearing fruit annually for over a quarter of a century in some instances, and yet to be but solitary specimens of their kind in their immediate location. As a rule, the chance of a new departure perpetuating itself was small, but sometimes circumstances seemed to favor the production of seedlings. Once in a while, under the trees in a Pine, Oak, Maple, or other forest, or under large trees, numerous seedlings might be noticed. It was only when a new departure found itself under these exceptional cases, that enough trees would be produced to extend and perpetuate the race, and then it was that we had to recognize the distinct variety, or even species, as we often had to call the departure by reason of its great distinctness from its parental form.

Mr. Meehan referred to some recent discussions on variation in Indian Corn. Cross-fertilization often made great changes in the immediate coloring of the seeds. There were some who argued that change comes also from innate power to vary. Such instances as this of the Honey Locust confirmed this view.

DECEMBER 8.

The President, Dr. LEIDY,

Thirty-one persons present.

A paper entitled, "On some new sp
Frank Aaron, was presented for publica

DECEMBER 15.

Mr. JOHN H. REDFIELD in

Twenty-five persons present.

A paper entitled "Methods of Defence
Morris, was presented for publication.

The following was ordered to be print

NOTES ON THE LAFAYETTE SERPENTINE BELT.

BY THEO. D. RAND.

It is well known that two nearly parallel belts of Serpentine and Steatite cross the Schuylkill above and below Lafayette Station, and pass southwestwardly towards the Pennsylvania Railroad. The southeasternmost, or steatite belt, cannot be observed beyond a bend in the Black Rock road, about one-half mile north of the railroad, the other was conspicuous at Rosemont Station, but no outcrop was known southwestward until within three-fourths of a mile of Darby Creek, on Meadow Brook, whence southwestwardly it was continuous, or nearly so, to Palmer's mills on Crum Creek.

This line is not easily identified with either of the former, but I have recently found a distinct outcrop on the Roberts road, on the property of Col. Jos. F. Tobias, or of Dr. Edward H. Williams, with fragments in the soil of the fields of the former to the northeast. The belt is very narrow, and the valley of a small creek seems to occupy nearly the same line. This outcrop is about half way between the Rosemont and Meadow Brook outcrops, and seems to prove beyond question that the belt crossing Darby Creek is the Lafayette belt. On the Roberts road, northeast of the Serpentine and measured at right-angles to the strike, perhaps 100 to 200 feet distant, is a rock bearing great resemblance to the Eurite of Barren Hill, Wayne, etc., occupying here almost exactly the position relative to the Serpentine and the Laurentian axis that the Eurite does on the northwestwardly side of the Laurentian, near Radnor Station. Its strike is N. 30° E., dip 50° to S. E. Adjacent mica schist N. 40° E., dip 65° to S. E.

The position of this outcrop of Serpentine somewhat south of the line of the Lafayette belt, indicates either a change in the strike, or the echelon structure elsewhere observable in the Serpentine of the adjacent region.

DECEMBER 22.

The President, Dr. LEIDY, in the chair.

Twenty-nine persons present.

A paper, entitled "Inclusions in the Granite of Craftsbury, Vermont," by Calvin McCormick, was presented for publication.

Worms in Ice.—Prof. LEIDY referred to a former communication on the occurrence of organisms in ice (see Proc. 1884, 260), and stated that Dr. S. C. Thornton, of Moorestown, N. J., a couple of weeks since, had submitted to him for examination a bottle of water from melted ice, such as was habitually used in his family, and in which he said he had observed living worms. A number of these proved to be present in the specimen, but were all dead. Having expressed a desire to confirm the statement that the worms were observed alive in the fresh ice-water, Dr. Thornton last week had obligingly sent him a basket of the ice. This was part of the provision made nearly a year ago from the vicinity of Moorestown. The ice was full of air bubbles and water drops. On being melted a number of the worms were liberated and proved to be in a living and quite active condition. It is probable that while imprisoned in the ice they may not have been frozen, but perhaps remained alive in a torpid condition in water drops. It is a remarkable fact that these animals should remain so long alive in the ice, and yet die so readily in the melted water subsequently. The worms are of the same species noticed in the ice-water of the first communication, and which was derived from similar ice procured from a mill-pond in Delaware Co., Pa. These facts would indicate that it is desirable to avoid the spongy ice from stagnant waters, as being liable to retain organisms which would be detrimental to us. In the clear ice, such as is served in Philadelphia, no living organisms are detected. The little worms of the ice appear to be an undescribed species, and may therefore be characterized as follows:—

LUMBRICUS GLACIALIS. Worm from four to six lines long, translucent white, cylindrical, anteriorly acute, tapering most behind and obtuse, of from 35 to 50 segments; oral segment with a blunt conical upper lip, unarmed and eyeless; succeeding segments with four rows of podal-spines, in fascicles of three; spines pointed at the free end and hooked at the attached end, nearly straight or slightly sigmoid; generative organs occupying the interval of the third and seventh spine bearing segments.

Thickness of worm 0·15 to 0·25 mm.; podal spines 0·3 to 0·375 mm. long

The length given in the former notice should be in lines instead of millimetres.

DECEMBER 29.

Mr. THOMAS MEEHAN, Vice-President, in the chair.

Thirty-three persons present.

The following were ordered to be printed:—

A CATALOGUE OF THE FISHES OF BEAN BLOSSOM CREEK, MONROE COUNTY, INDIANA.

BY CARL H. EIGENMANN AND MORTON W. FORDICE.

Bean Blossom is a small creek crossing Monroe County about six miles north of Bloomington. It is a tributary of White River and empties into it near Gosport, Indiana. It is a rather sluggish stream with gravelly bottom, and considerable grass and water-weeds. The specimens were collected by parties of students of the Indiana University, visiting the creek at different times. Thirty-two of the species were also obtained by us on the 12th of September, 1885.

1. *Ammocœtes branchialis* L. Abundant in spring.
2. *Noturus gyrinus* Mitchill.
3. *Noturus miurus* Jordan. Very abundant.
4. *Noturus flavus* Rafinesque. Very common. The last two species are very abundant in the weeds of shallow water; only two specimens of *gyrinus* were obtained.
5. *Noturus exilis* Nelson. One specimen.
6. *Leptops olivaris* Rafinesque.
7. *Amiurus melas* Rafinesque.
8. *Amiurus natalis* Le Sueur.
9. *Catostomus teres* Mitchill. Very abundant.
10. *Catostomus nigricans* Le Sueur. Abundant.
11. *Minytrema melanops* Rafinesque. Abundant.
12. *Moxostoma macrolepidotum* Le Sueur.
13. *Campostoma anomalum* Rafinesque.
14. *Chrosomus erythrogaster* Rafinesque.
15. *Hybognathus nuchalis* Agassiz.
16. *Notropis whipplei* Girard.
17. *Notropis megalops* Rafinesque.
18. *Notropis ardens lythrurus* Jordan.
19. *Rhinichthys atronasus* Mitchill.
20. *Hybopsis biguttatus* Kirtland.
21. *Hybopsis amblops* Rafinesque.
22. *Semotilus atromaculatus* Mitchill.
23. *Esox vermiculatus* Le Sueur.
24. *Labidesthes sicculus* Cope. One specimen.
25. *Aphredoderus sayanus* Gilliams. One specimen.
26. *Pomoxys annularis* Rafinesque. Very abundant.
27. *Pomoxys sparoides* Lacépède.
28. *Ambloplites rupestris* Rafinesque.
29. *Lepomis cyanellus* Rafinesque.

30. *Lepomis megalotis* Rafinesque. Abundant.
31. *Micropterus dolomiei* Lacépède. Abundant.
32. *Boleosoma olmstedi maculatum* Agassiz. Abundant.
33. *Diplesion blennioides* Rafinesque. Abundant.
34. *Percina caprodes* Rafinesque. Abundant.
35. *Hadropterus phoxocephalus* Nelson.
36. *Hadropterus scierus* Swain. Abundant. Several specimens were taken five inches in length. In these large specimens the serration of the preopercle is obsolete.
37. *Hadropterus aspro* Cope and Jordan.
38. *Etheostoma flabellare* Rafinesque. Abundant.
39. *Etheostoma cæruleum* Storer.
40. *Uranidea richardsoni* Agassiz.

LIST OF FISHES COLLECTED IN HARVEY AND COWLEY COUNTIES, KANSAS.

BY BARTON W. EVERMANN AND MORTON W. FORDICE.

About the last of May, 1884, Mr. Evermann made a small collection of fishes at Newton and Winfield, Kansas. The specimens from Newton are from a small stream called Sand Creek, which flows into the Little Arkansas, a tributary of the Arkansas. Those from Winfield were obtained from Timber Creek, a tributary of Walnut River, which flows into the Arkansas.

Sand Creek was seined just below a small dam near the town of Newton, where the water is clear and the bottom sandy. Farther down the creek was made up of numerous pools of various sizes, and with bottoms and shores more or less muddy.

Timber Creek is a sluggish stream, with usually muddy bottom and water not clear.

We here give a list of the species represented in the collection as identified by us. All are now in the museum of the Indiana University :—

1. *Amiurus melas* (Raf.). Found to be very abundant in Timber Creek, but no specimens were obtained at Newton.
2. *Moxostoma macrolepidotum* (Le S.). Sand Creek. Only one specimen.
3. *Campostoma anomalum* (Raf.). Common in both streams examined.
4. *Pimephales promelas* (Raf.). Eight very fine specimens (all males) were gotten from a small stream which flows into Timber Creek near Winfield.
5. *Pimephales notatus* (Raf.). A few specimens were obtained at Newton.
6. *Notropis lutrensis* (Baird and Girard). Very abundant in both streams.
7. *Notropis topeka* Gilbert. Sand Creek. Only two specimens were obtained.
8. *Notemigonus chrysoleucus* (Mitchill). Found only in Sand Creek. One specimen.
9. *Fundulus zebrinus* Jordan and Gilbert. This species was found to be common both at Newton and Winfield.
10. *Zygonectes notatus* (Raf.). A few specimens only were received—all from Timber Creek.
11. *Labidesthes sicculus* Cope. From Timber Creek only. Not common.
12. *Lepomis cyanellus* Raf.. Abundant in Timber Creek.
13. *Lepomis megalotis* (Raf.). But two specimens were obtained—one from Newton, the other from Winfield.
14. *Lepomis humilis* (Girard). Abundant in both streams.
15. *Etheostoma cæruleum* Storer. Very abundant in Timber Creek. None were obtained at Newton.

The following annual reports were read and referred to the Publication Committee:—

REPORT OF THE RECORDING SECRETARY.

The Recording Secretary respectfully reports that during the year ending November 30, 1885, fourteen members and one correspondent have been elected.

Resignations of membership have been received and accepted on the usual conditions, from J. H. Brinton, M. D., W. S. Baker, Jos. C. Wright, R. B. Haines, Jr., and Jos. G. Richardson, M. D.

The deaths of ten members and six correspondents have been announced, and duly recorded in the printed Proceedings.

Thirty-four papers have been presented for publication, as follows: Willis S. Blatchley, 3; Angelo Heilprin, 2; Herman Strecker, 2; Alan F. Gentry, 2; S. H. Scudder, 2; Charles Morris, 2; Carl H. Eigenmann and Morton W. Fordice, 2; S. E. Meek and Robt. Newland, 2; Walter R. Furness, 1; F. Lamson Scribner, 1; F. Warrington Eastlake, 1; Dr. Benj. Sharp, 1; Leonard Stejneger, 1; H. C. Lewis, 1; W. D. Hartman, 1; W. B. Scott, 1; W. N. Lockington, 1; Theo. D. Rand, 1; Morton W. Fordice, 1; B. W. Evermann and M. W. Fordice, 1; B. W. Evermann and S. E. Meek, 1; Seth E. Meek and Edw. A. Hall, 1; Edw. A. Hall and J. Z. A. McCaughan, 1; Charles Wachsmuth and F. Springer, 1; Ernst P. Bicknell and Fletcher B. Dressler, 1.

Twenty-nine of these have been printed in the Proceedings of the Academy, two have been withdrawn by the authors, and the remaining three have been reported on favorably and will form part of the next volume of the Proceedings.

Sixty-three pages of the volume for 1884, and three hundred and eighty-four pages of that for the current year, have been printed. The former are illustrated by two lithographic plates, and the latter by three.

Forty foreign societies have been added to the list of exchanges during the year, increasing the number of copies of the Proceedings sent abroad in exchange to 375.

The average attendance at the meetings during the past twelve months has been 25. Verbal communications have been made by thirty-four members. The greater number of these have been

reported by the authors and printed in the Proceedings, constituting an important portion of the annual volume.

At the meeting of the Council held Nov. 23, Mr. Jacob Binder was reappointed Curator of the Wm. S. Vaux Collections.

All of which is respectfully submitted.

EDW. J. NOLAN,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

The correspondence of the past year shows a gratifying increase in the number of societies and institutions with which we are now exchanging our publications. The increase has arisen in many instances at the request of the Academy, and in a certain number at the solicitation of the societies.

The opening of correspondence with societies not previously on our list of exchanges brings with it in time a request from them for our earlier publications, more particularly the Proceedings. The earlier volumes are in very limited stock, and the Corresponding Secretary suggests the desirability of re-publication at as early a date as the ability of the Academy will admit.

During the year there has been but one correspondent elected, who has been promptly notified of his election. Responses have been received from nine correspondents, of which number eight were elected in the preceding year. Three have acknowledged the reception of the diploma. In a few instances official notice of the death of Correspondents has been received. Usually such information is obtained from the journals, and becomes part of the minutes of the Academy.

Letters and cards to the number of one hundred and twenty-two have been received acknowledging our publications, the large number being partly due to the increase before mentioned, and partly to the early distribution of our Proceedings in parts through the mails.

Letters of transmission numbering forty-seven have been received, the smallness of the number arising from the decreasing number of correspondents, who from preference or necessity transmit their publications through the Smithsonian Institution.

Miscellaneous letters, numbering thirteen, have been received, and, when necessary, have been answered.

The additions to the Museum will appear in the Curator's report. The donors have received prompt acknowledgment through the Curator-in-charge, who has kindly acted for me.

Respectfully submitted,

GEORGE H. HORN, M. D.,
Corresponding Secretary.

REPORT OF THE LIBRARIAN.

During the year ending November 30, 1885, 4100 additions have been made to the library of the Academy. This is an increase of 678 over the growth of last year, and of 1097 over that of 1883. The accessions have consisted of 986 volumes, 3047 pamphlets and parts of periodicals, and 67 maps.

They have been derived from the following sources:—

Societies,	2158
Editors,	793
I. V. Williamson Fund,	574
Authors,	266
Department of the Interior,	35
Geological Survey of Michigan,	33
Wilson Fund,	25
Treasury Department,	21
Geological Survey of Russia,	19
Geological Survey of India,	16
Joseph Jeanes,	15
Geological Survey of Pennsylvania,	14
Geological Survey of Sweden,	14
Geological Survey of Canada,	14
University of the State of New York,	11
Smithsonian Institution,	7
War Department,	7
Department of Agriculture,	7
Geo. W. Tryon, Jr.	7
Geological Survey of New Jersey,	6
California State Mining Bureau,	5
H. B. M. Government,	5
Minister of Public Works in France,	4
Geological Survey of Minnesota,	4
British Museum,	4
Thomas Meehan,	3
John H. Redfield,	3
Norwegian Government,	3
Isaac Lea,	2
Geological Survey of New Zealand,	2
U. S. Civil Service Commission,	2
W. P. Collins,	1
Mrs. J. Lawrence Smith,	1
Asa Gray,	1
Mrs. Emma Rogers,	1
C. S. Sargent,	1
Bureau of Ethnology,	1
Royal College of Surgeons,	1
Mining Registrars, Victoria,	1
Navy Department,	1
East Indian Government,	1
Lea Bros. & Co.	1
U. S. Fish Commission,	1
Publishers,	1
Raffles Museum, Singapore,	1
Geological Survey of Indiana,	1
Department of Mines, Nova Scotia,	1
Indian Museum,	1
Public Library, Cincinnati,	1
Minister of Works, Mexico,	1
Geological Survey of Minnesota,	1
Forestry Commission, New York,	1

These additions have been distributed to the several departments of the library as follows:—

Journals,	3325	Mineralogy,	13
Geology,	355	Education,	11
General Natural History,	110	Ichthyology,	8
Botany,	100	Agriculture,	7
Conchology,	71	Mammalogy,	5
Entomology,	37	Helminthology,	4
Physical Science,	28	Herpetology,	3
Anatomy and Physiology,	22	Chemistry,	3
Anthropology,	20	Encyclopedias,	3
Voyages and Travels,	19	General Literature,	1
Ornithology,	16	Medicine,	3
Bibliography,	16	Miscellaneous,	25

The year's improvement on the usual rate of increase has been mainly due to the generous response made by corresponding societies to our applications for exchanges and deficiencies. Our efforts to increase and perfect as far as possible the Academy's sets of scientific periodicals have been unremitting, with the gratifying result above noted. In compliance with our proposition made more than a year ago, many corresponding societies continue to send their publications promptly by mail when issued, instead of as formerly once or twice a year through the Bureau of Exchange. The publications of the Academy are, of course, sent in return by mail, and, although the cost of postage, amounting during the past year to $117.59, is a matter of considerable importance in the present cramped financial condition of the society, the outlay is believed to be a most judicious one.

Among the more important additions to the special departments of the library acquired during the year have been complete sets, as far as published, of Barrande's Systême Silurien de la Bohéme, Reichenbach's Icones Floræ Germanicæ, and Godman and Salvin's Biologia Centrali-Americana. For these, as for nearly all the other important additions apart from our exchanges, we are indebted to the liberality of Mr. Isaiah V. Williamson.

The rapid increase of the library has rendered inadequate the hand catalogues of the special departments in use for many years. No matter how much space may be left for additions, it has been found impossible to preserve the unbroken alphabetical arrangement upon which their usefulness depends, while the transcripts from the cards involve an unnecessary expenditure of time and labor. A copy of the present card catalogue has therefore been commenced with the efficient assistance of Sig. Emanuele Fronani,

whose services I have been again enabled to avail myself of during the summer months. The entries have been made on cards of the best quality manufactured for the purpose by the American Library Bureau. They are perforated near the middle of the lower margin and will be held in their places in drawers or trays by rods, thus avoiding the possibility of accidental disarrangement. The chance of such an accident has made it inadvisable to open for general use the present catalogue, which is complete to date, as the cards are arranged in drawers without guards, and any confusion of the alphabetical arrangement would make it worse than useless.

A shelf catalogue has also been commenced. This consists of the briefest author and title entries of the books as they are at present numbered and placed in the cases. This will be a necessity of library administration when the card catalogue is alone in use for reference, as without it a great expenditure of time would be necessary to determine what books may be lost or misplaced.

I regret to say that for the same reason as that noted last year—lack of means—no books have been bound since my last report. The necessity for binding some of our accumulations has, however, become so great that during the coming year a portion of the income of the I. V. Williamson Fund will be appropriated for the binding of books credited to said fund.

A detailed list of accessions is herewith submitted.

EDW. J. NOLAN,
Librarian.

REPORT OF THE CURATORS.

The Curators present the following statement from the Curator-in-charge, Prof. Angelo Heilprin, as their report for the year ending November 30:

During the past year, as in preceding years, much of the work accomplished in the Museum has been voluntary—this more especially in the departments of Conchology and Botany, to the special conservators of which the Academy feels itself under lasting obligation. A similar obligation attaches to the labors of the conservator of the Mineralogical department covered by the Wm. S. Vaux trust, a special report pertaining to which has

been submitted to the Council. In the department of Entomology the partial services of a paid assistant, employed in joint association with the American Entomological Society, have been secured.

In departments other than those here specified the work accomplished has been under the immediate direction of the Curator-in-charge and his assistants who have received material aid in various ways from the several Jessup Fund beneficiaries. While it is believed much has been done toward bringing the collections into a relational sequence, and in the identification and labeling of specimens, years of labor still remain before, at the present rate of progress, the entire Museum can be brought into systematic order. Nor, it appears, will the attainment of this much-desired object be practicable until further and greatly-increased accommodation for the proper exposition of the steadily increasing collections be furnished. Reflectively, again, the want of space acts as a material check to the proper development of the collections, which, in the estimation of donors, can now no longer be exhibited to advantage. The following extract from the Report of the Professor of Ethnology and Archæology illustrates this condition: "The collections of the Academy in this department are substantially the same as noted in the last report. It would be easy to increase them were there ample accommodations for their favorable display as objects." The extensive series of rocks and fossils collected by the Second Geological Survey of the State of Pennsylvania, and contained in upwards of 200 cases, still remain boxed, awaiting the opportunity when an increase of space will permit of their classification and display.

It is earnestly hoped that the contemplated extension, either in part or in whole, of the present building, which is imperatively demanded by the needs of the institution, may be shortly realized, but toward the attainment of this end assistance, other than that which can be furnished by the Academy alone, is necessary. The present resources of the Academy are in themselves scarcely sufficient to maintain the institution as it is now situated, and much too limited to enable it to fully meet the requirements of scientific investigators and investigation. A Curator's fund for the liberal purchase of specimens may be indicated as a growing absolute necessity, and scarcely less so a

fund to be used for the prosecution of zoo-geographical explorations. The interest derived from a principal fund of some $50,000 to $60,000 would fairly equip annual expeditions to regions that have been thus far little, or not at all, investigated —Florida, the West Indies, Mexico, Central America, or Labrador, for example—and permit of a large amount of material to be collected for the use of naturalists generally.

The special curatorial work during the past year has been mainly in connection with the departments of Vertebrate and Invertebrate Palæontology and Osteology. The entire collections of fossil fishes, reptiles and mammals have been brought together, properly arranged and classified, and constituted into distinct sections or departments. The specimens of osteology have been largely identified and classified, and are now in a condition to be advantageously used by the student and specialist. A special collection, intended to illustrate the type forms of animal life, from the highest to very nearly the lowest, designed to facilitate the work of the zoological student, is rapidly approaching completion, although still requiring a system of improved explanatory labeling.

The routine work connected with the curatorial office has been accomplished as heretofore, and requires no special enumeration of details. The institution has benefitted during the year through the services of five Jessup Fund beneficiaries, covering as many distinct departments.

Very respectfully,

ANGELO HEILPRIN,
Curator-in-charge.

JOS. LEIDY,
Chairman Curators.

REPORT OF THE CURATOR OF THE WILLIAM S. VAUX COLLECTIONS.

The Curator of the William S. Vaux collections respectfully reports:—

The collections are in good condition, no change having been made in the arrangement except that which was rendered necessary by the addition of one hundred and four mineral specimens,

which have been purchased for the collection out of the funds provided for that purpose. The additions have been arranged according to the system of classification adopted.

According to the report of 1884, the mineral specimens numbered, ...	6,412
Additions purchased during the current year, ending Nov. 30, 1885, ...	104
Total, ...	6,516
Archæological specimens (same as noted in report of 1884), ...	2,940

The Mineralogical collection has a wide reputation, and has been visited by a large number of persons during the year, many of them prominent mineralogists. Those who had examined the collection previous to the decease of William S. Vaux, have noticed the absence of a number of the most remarkable specimens which it formerly contained and which added so much to its fame. It is to be regretted that those specimens should have been separated from the others, thereby decreasing its importance as a mineral collection, and as a memorial of the decedent.

The following specimens, numbering 104, have been purchased during the year and placed in the collection at the aggregate cost of $542.95 :—

1884, December 1.—Four specimens of tourmaline, two gold crystals, one fowlerite, cat's-eye (Ceylon), chalcopyrite, pisolite, zircon (white), jasper (from the Nile), crocidolite, ruby (cut spec.), N. J., sapphire (purple), sapphire (white), turquoise, turquoise (Persian), citron (Orange Co.), citron (pale yellow), amethyst.

1885, March 30.—One specimen of crocidolite, bastnäsite, two wulfenites (Nev.), one barite, wulfenite (red), vanadanite, anatase.

April 20.—One specimen of hematite, chiastolite.

April 30.—Tray of concretions.

May 4.—One specimen of chalcedony, chalcedony with bubble, hornblende.

May 5.—One specimen of corundum, moss agate, maconite, analcine on copper, jade, beryl, diaspore on corundum, cassiterite, two tourmalines (green), one lepidolite, pectolite, tourmaline on cookeite.

March 5.—Three specimens of rutile, one chiastolite.

March 24.—Nine specimens of small diamonds.

March 25.—One specimen of lepodolite, hornblende, staurolite.

May 27.—Two specimens of descloisite, one vanadanite, diamond on matrix, quartz (mod. crystal), calamine, smithsonite, smithsonite (geode).

September 10.—One specimen of quartz on hematite, azurite, colemanite, leidyite.

September 27.—Two specimens of obsidian or pearl spar, one fluorite (polished), opal.

October 13.—One specimen of apophyllite, polydelphite, dysluite.

October 13.—Two specimens of calamine, one franklinite, zincite, willemite, zincite, two rhodenites.

November 9.—Two specimens of topaz, one beryl (green cut), beryl (yellow cut), essonite.

Brush's Blowpipe Analysis and Dana's Text-book of Mineralogy were purchased for the use of the Curator.

Respectfully submitted,

Jacob Binder,
Curator.

REPORT OF THE BIOLOGICAL AND MICROSCOPICAL SECTION.

The number of meetings held during the year ending December 1, 1885, was sixteen.

The average attendance was ten.

The following members were elected: Dr. Horace F. Jayne, Dr. J. Bernard Brinton.

The following members resigned: Dr. Persifor Frazer, W. T. Seal, Dr. J. D. Thomas, Dr. J. G. Richardson.

The following were some of the more important communications brought before the Section:—

December 15, 1884. By Dr. Benjamin Sharp, upon "Homologies of the Vertebrate Lens."

January 5, 1885. Dr. Benjamin Sharp, upon "The Formation of Teeth in Ancyllus."

January 5. By Miss Fielde, upon "The Process of Regeneration of Parts of the Earth Worm;" by Dr. Horace F. Jayne, upon "A Process of Staining."

January 19. Lecture by Dr. G. A. Rex, "Illustrations of the Genus Stilbum."

February 16. Lecture by Dr. W. X. Sudduth, upon "The Comma Bacillus;" exhibition by Messrs. Queen & Co. of Bacteria.

March 16. By Mr. Harold Wingate, upon "The Lens of the Triton."

April 6. By J. Bernard Brinton, upon "Opaque Mounting."

April 20. By Dr. J. Brewer Hall, upon "A Species of Ochlea."

May 4. By Dr. Benjamin Sharp, upon "The Eyes of the Pecten."

A microscopical exhibition was given to the public upon the evening of Thursday, December 3. It was attended by a large and appreciative company.

Very respectfully,

Robt. J. Hess, M. D.,
Recorder.

REPORT OF THE CONCHOLOGICAL SECTION.

The Recorder of the Conchological Section respectfully reports that during the past year the Academy has continued to publish for the Section such papers on Conchology as have been presented. No new members or correspondents have been elected, neither has there been any change in the by-laws. Mr. Tryon, Conservator, reports as follows:—

"During the year there has been a marked increase over any recent one in the additions to our Museum. Sixty donations and purchases have been received from forty-four persons. The number of trays and labels added to the collection is 1484, of specimens 7237.

"The Conchological Museum now contains 43,932 trays and written tablets, and 158,352 specimens.

"A detailed list of the accessions for 1885 is hereunto subjoined. (See Additions to Museum.)

"A circular was issued early in the year soliciting collections of shells from localities not represented in our Museum. Numer-

ous offers were received in response, and from them a number of selections have been made which have greatly enriched our geographical and varietal suites. The Singapore series (referred to in the last annual report) has been completed by Mr. Archer; Messrs. Bailey, Bedwall, Dupuy and Marie have added suites from Australia and New Caledonia; interesting collections from England, France and Sicily have been received from a number of collectors; our Florida series has been greatly enlarged by an important invoice from Mr. Henry Hemphill, who has spent two winters in dredging on the west coast of that State, and from other sources; many other American suites and specimens have been obtained, including particularly, a very fine suite of the shells of Philadelphia, presented by Mr. John Ford, and exhibited in our collection illustrative of Pennsylvania and New Jersey natural history.

"The additions for the year have all been labelled and mounted, mainly by Mr. Frank Stout, who has very satisfactorily performed this duty.

"The work of redetermining and arranging the collection, which goes on in connection with the publication of monographs of the genera in the 'Manual of Conchology,' progresses. The Cassididæ, Doliidæ, Ovulidæ, Strombidæ, Naticidæ, Vitrinidæ, Limacidæ, and a portion of the Zonitidæ, have thus been carefully studied by your conservator, and the Cypræidæ by Mr. S. R Roberts.

"In the last report attention was called to the overcrowding of the shell cases, as seriously interfering with the exhibition of all the species to the public. Having recently secured the assistance of Mr. Wm. B. Marshall, an enthusiastic student of conchology, your conservator has been able to commence the realization of plans, long since matured, by which this overcrowding will be remedied. All duplicates will be removed from the cases to the drawers under them, where they will be rearranged to constitute what may be called the Geographical Collection, illustrative of the distribution and variation of the several species. Part of the space thus gained in the cases will be occupied by colored figures (from the 'Manual of Conchology') of all the species of which we have no specimens. These figures, mounted and labeled like the specimens, will, together with the latter, represent all the species and varieties of shells and mollusks known to

science, so far as they have been figured. In addition to these, a third, to be known as the Synoptical Collection, and introductory to the others, is intended to contain representatives of all the recent, and the most important of the fossil genera and subgenera, with printed labels, including the name, description, distribution, synonymy, etc. Figures of the animals, lingual dentition and other details are being added to make this series more complete.

"Enough has been accomplished to give a fair idea of the practical working of these plans; to complete them will require the labor of perhaps ten or twelve years.

"To enumerate them in order, the Conchological Cabinet of the Academy will consist of five distinct series or collections, so arranged as to facilitate comparison from one to another, yet each fully equipped for separate study, as follows: 1, Synoptical Collection, contained in table cases; 2, Alcoholic Collection, in wall cases (recently rearranged by Mr. Marshall); 3, Systematic Collection, in table cases; and in the drawers under these, 4, Geographical Collection, and 5, the Swift Collection, given to the Academy upon condition that it be kept intact."

The officers of the section are :—

Director, . . .	W. S. W. Ruschenberger, M. D.
Vice-Director, . .	John Ford.
Recorder, . . .	S. Raymond Roberts.
Secretary, . . .	John H. Redfield.
Treasurer, . . .	Wm. L. Mactier.
Conservator, . .	George W. Tryon, Jr.
Librarian, . . .	Edward J. Nolan, M. D.

Respectfully submitted, by

S. Raymond Roberts,
Recorder.

REPORT OF THE ENTOMOLOGICAL SECTION.

The Recorder of the Entomological Section respectfully reports that nine meetings of the Section have been held during the past year. An increased interest in the proceedings of the Section has been shown by a larger average attendance at the meetings.

One member has been elected.

A synopsis of the Section meetings is published by the American Entomological Society, in connection with its Transactions. That society still continues the publication of the entomological articles presented to it, and has printed thirteen of the same during the past year, amounting to 300 pages, with 9 plates.

The papers published and their authors are as follows:—

Short studies of North American Coleoptera, by John L. LeConte, M. D. (posthumous).

A study of some genera of Elateridæ, by George H. Horn, M. D.

On the North American Asilidæ, Part II, by S. W. Williston, M. D.

On the systematic position of some North American Lepidoptera, by John B. Smith.

A study of the species of Cryptobium of North America, by George H. Horn, M. D.

Studies among the Meloidæ, by the same.

Descriptions of new North American Scarabæidæ, by the same.

Contributions to the Coleopterology of the United States, by the same.

On the species of Canthon and Phanæus of the United States, with notes on other genera, by Frederick Blanchard.

Descriptions of some new Cerambycidæ, with notes, by George H. Horn, M. D.

Synopsis of the Throscidæ of the United States, by George H. Horn, M. D.

A monograph of North American Chrysididæ, by S. Frank Aaron.

On the earlier stages of the Odonata, by H. A. Hagen, M. D.

In addition, shorter papers on Cynipidæ, by W. H. Ashmead, have appeared in the Proceedings.

The collections in the cabinets have received more attention during the past year than for some time previous. A great part has been thoroughly arranged and labeled where needed. Also a thorough process of disinfection has gone on, and the cases cleared of all troublesome matter. That this work might be better done, the American Entomological Society employed a

custodian during nine months of the year, at a small compensation, to attend to the same.

A number of accessions to the cabinets have been received this year, from Messrs. R. H. Stretch, E. M. Aaron, S. F. Aaron, W. H. Ashmead, J. S. Johnson, and James Behrens. Many of these additions are rare, or new to the collections.

The officers elected for the ensuing year are as follows :—

Director, ...	George H. Horn, M. D.
Vice-Director, . . .	Rev. Henry C. McCook, D. D.
Recorder, . . .	J. H. Ridings.
Treasurer, . . .	E. T. Cresson.
Conservator, . . .	Henry Skinner, M. D.

Respectfully submitted,

J. H. Ridings,
Recorder.

REPORT OF THE BOTANICAL SECTION.

The Vice-Director of the Botanical Section of the Academy respectfully reports that the section continues its steady progress as in former years. 1687 species of phanerogamic plants and vascular cryptogams were added to the Herbarium last year, of which 395 were new to our collection; 395 species of lichens and fungi were also received. A complete count of the species in the Herbarium has been made and found to foot up 25,413, of which all but about 3075 are named and in place. These are exclusive of Fungi and Lichens. The details of the donations will be found in the Conservator's report attached.

The section is wholly free from debt, and has a balance of one hundred and seventy-six dollars in its treasury. We have lost the services of our late Recorder, Mr. F. L. Scribner, who has removed to Washington, to a wider sphere of usefulness.

Meetings have been held at every stated period during the year, and valuable contributions to botanical knowledge have been made by Messrs. Meehan, Redfield, Rothrock, Scribner, Brinton, Burk, Canby, Hoopes, and A. H. Smith—some of which, fully, or in brief, have been published in the *Proceedings of the Academy*.

The officers elected for the coming year are :—

Director, . . .	W. S. W. Ruschenberger, M. D.
Vice-Director, . .	Thomas Meehan.
Recorder, . . .	Charles Schaeffer, M. D.
Treasurer, . . .	Isaac C. Martindale.
Cor. Secretary, . .	Isaac C. Martindale.
Conservator, . .	John H. Redfield.

Submitted,

THOMAS MEEHAN,
Vice-Director.

Conservator's Report for 1885.—Since the last annual report, the Conservator has completed the provisional lists of species contained in the Herbarium, so far as refer to the phanerogamic orders and the vascular cryptogams. These lists are strictly provisional and temporary, intended to facilitate ready access to the contents of the Herbarium, and in no way to take the place of such careful revision as is greatly needed, but which must necessarily require much time, and more careful study than can now be bestowed. It is greatly to be desired that the same work should be continued in the lower cryptogamic orders, and it may not be amiss here to suggest to those of our associates in the Microscopical Section who are directing their attention to the structure of these lower forms of vegetable life, that here is an excellent opportunity to utilize in systematic work the technical training they have received.

So far as the lichens are concerned, this work has been accomplished by our fellow member, Dr. J. H. Eckfeldt, who has not only catalogued the species of that order contained in the Herbarium, but has also contributed largely to supplying deficiencies.

The enumeration of the phanerogamic species contained in the Academy's Herbarium, which was referred to in the last report, has been completed, and the result is, . . . 24,268 species.
To this add Ferns, Lycopods, Equisetaceæ, Marsiliæ and Isoeteæ, ... 1,145

Total phanerogams and vascular cryptogams, 25,413
Approximating very closely to the estimate in the last report.

The attention to the proper mounting of the specimens in the Herbarium has been continued, with the efficient aid of Mr.

Burk. A large part of the new accessions have been moun and the same work has been prosecuted in the North Amer Herbarium, of which now about one-half has received this so necessary to the permanent preservation of the specimens

The donations received during the year amount to 1687 sp of phanerogams and ferns, and 383 species of lichens and fu in all 2070 species. Of the former, 395 species are new to Herbarium, while probably a large part of the fungi and lic are also new to us. The total number of species presented is than in some former years, but it will be seen that the propor of *new* accessions is not materially diminished. Of the species received 1366 are North American, 37 South Amer and 667 are from the old world.

Among the donations we may specify the valuable contribu of exotic plants received from Dr. Asa Gray of the Cambr Herbarium; a series of 365 species collected by Mr. Meeha Western North America in 1883; and a valuable collection of species of S. African, Australian and European plants from Wm. M. Canby.

A complete list of the donations accompanies this report, will appear in its proper place in the list of Additions to Museum.

JOHN H. REDFIELD,
Conservato

REPORT OF THE MINERALOGICAL AND GEOLOGICAL SECTION.

The Director of the Mineralogical and Geological Sectio the Academy of Natural Science would respectfully report meetings of the Section have been regularly held, but that o to the absence of active members, and other causes, the att ance has not been as large as in former years. Consider accessions to the cabinet have been made—a number of desir specimens having been purchased with the funds of the Sec

Respectfully submitted,

THEO. D. RAND,
Directo

REPORT OF THE PROFESSOR OF INVERTEBRATE PALEONTOLOGY.

The Professor of Invertebrate Paleontology respectfully reports, that during the year he has delivered a course of twenty-seven lectures (with practical demonstration) on paleontology, which, as heretofore, has been attended largely by teachers of the various city schools. A special course on geology, arranged at the request of the Teachers' Institute of Philadelphia, was also delivered in the Hall of the Academy, as a continuation of a similar course given before the same body in the spring and autumn of 1884. The attendants at these lectures numbered between 100 and 150. Both courses of instruction in the class-room were supplemented by a number of field excursions in the region about Philadelphia, ranging to Orange, N. J., and the Atlantic coast, and by a twelve days' trip to the Valley of the Upper Delaware.

The collections of the Academy in the department of Invertebrate Paleontology have received no very material accessions during the year; special mention may be made of a beautiful slab of crinoids, from the Carboniferous Limestone of Iowa, generously given to the Society by Mr. Charles Wachsmuth, whose important papers on the Paleocrinoidea, prepared in conjunction with Mr. Springer, are being published in the Proceedings of the Academy.

Through a re-arrangement of the collections contained in the Museum opportunity has been afforded for the proper arrangement and display of the collections illustrating European paleontology, which have up till now been largely inaccessible and placed in drawers. The proper identification and labeling of species will, however, be a matter of time.

Very respectfully,

ANGELO HEILPRIN,
Prof. of Invertebrate Paleontology.

REPORT OF THE PROFESSOR OF INVERTEBRATE ZOOLOGY.

The Professor of Invertebrate Zoology respectfully reports that during the past year he has delivered a course on some of

the Principles of Zoology, consisting of about twenty (20) lectures.

He further reports that the collections under his charge have somewhat increased, the increase not being as great as that of the previous year.

The principal donation was a collection of Echinoderms, presented by Mr. John Ford.

A few crustaceans were presented by Mr. C. McCormick.

A course of ten lectures will be given in the spring of the coming year (April and May), the subject being, "Special Senses."

Very respectfully,

BENJAMIN SHARP,
Professor of Invertebrate Zoology.

REPORT OF THE PROFESSOR OF ETHNOLOGY AND ARCHÆOLOGY.

I have the honor to report that during the year 1885 a course of ten lectures was delivered in the hall of the Academy, on the ethnology and archæology of America. They were illustrated with maps, drawings, and by means of specimens obtained from the various collections within the rooms of the Academy. The lecture hall was usually well filled, and quite as much interest was manifested by the audience as could be expected from the nature of the topics discussed.

The collections of the Academy in this department are substantially the same as noted in the last report. It would be easy to increase them, were there ample accommodations for the favorable display of objects.

Respectfully,

D. G. BRINTON, M. D.,
Professor of Ethnology and Archæology.

SUMMARY OF THE REPORT OF WM. C. HENSZEY, TREASURER,

FOR THE YEAR ENDING NOV. 30, 1885.

DR.

To Initiation Fees	$ 100 00	
" Contributions (semi-annual contributions)	1635 76	
" Life Memberships	400 00	
" Admissions to Museum	264 59	
" Sale of Guide to Museum	8 00	
" Publication Committee	525 55	
" Fees, Lectures on Palæontology	68 00	
" " " " Mineralogy	83 00	
" " " " Ethnology	48 50	
" " " " Zoology	6 00	
" Duplicate Books	2 00	
" Biological Section (for gas)	50 00	
" Miscellaneous	97 24	
" Correction of Proof (B. Sharp)	3 60	
" Interest from Mortgage investment, Joshua T. Jeanes' Legacy	1000 00	
" Wilson Fund. Toward Salary of Librarian	300 00	
" Publication Fund. Interest on Investments	355 00	
" Barton Fund. " " "	240 00	
" Life Membership Fund. " " "	165 00	
" Maintenance Fund. " " "	155 00	
" Eckfeldt Fund. " " "	125 00	
" Stott Legacy Fund. " " "	100 00	
" Maintenance Fd. Transf. by resolution of Academy	1013 14	
" Life Membership Fd. " " " " "	1500 00	
" Book Fund. " " " " "	3 13	
" Instruc. and Lec. Fd. " " " " "	86 65	
" Interest	16 25	
		$8351 41

CR.

By Balance overdrawn per last account	$1238 44	
" Salaries, Janitors, etc	3236 62	
" Freight	43 50	
" Repairs	85 67	
" Insurance	55 00	
" Printing and Binding Proceedings, etc	1055 36	
" Plates and Engravings	71 75	
" Printing and Stationery	92 40	
" Trays and Cards	71 47	
" Postage	195 26	
" Mounting Swan	5 00	
" Coal	55 00	
" Gas	88 77	
" Glass Jars and Vials	77 97	
" Subscription to U. S. Publication	2 00	
" Water Rents, 1885	33 35	
" Miscellaneous	452 20	
" Dr. D. G. Brinton. Fees from Lectures	48 50	
" Prof. H. C. Lewis. " " "	83 00	
" Prof. A. Heilprin. " " "	68 00	
" Life Memberships transferred to Life Membership Fund	400 00	
		$7459 26
Balance, General Account		892 15

THOMAS B. WILSON LIBRARY FUND.

By Balance per last statement		$ 277 [illegible]
For Books		220 05
Transferred to General Account, toward Salary of Librarian		300 00
		$797 [illegible]
Income from Investments		525 00
Balance overdrawn		$272 [illegible]

LIFE MEMBERSHIP FUND. (For Maintenance.)

By Investment, Bond and Mortgage		$1500 00
Transferred to General Account		165 00
		$1665 00
To Balance per last statement	$1000 00	
Interest on Investments	165 00	
Life Memberships transferred to this account	400 00	
		1565 00
Balance overdrawn		$100 00

BARTON FUND. (For Printing and Illustrating Proceedings.)

Interest on Investments		240 00
Transferred to General Account		240 00

JESSUP FUND. (For Assistance of Students.)

Balance per last statement		620 01
Interest on Investments		560 00
		1180 01
Disbursed		946 00
Balance		$234 01

MAINTENANCE FUND.

Balance per last statement		1013 14
Interest on Investments		155 00
		$1168 14
By Investment, Lehigh Valley Coal Co.'s Bonds	$1013 14	
Transferred to General Account	155 00	
		1168 14

PUBLICATION FUND.

Income from Investments		$ 355 00
Life Subscriptions to Proceedings and Journal		225 00
		$580 00
Transferred to General Account		355 00
Balance for Investment		$225 00

ECKFELDT FUND.

Income from Investments		$ 125 00
Transferred to General Account		125 00

I. V. WILLIAMSON LIBRARY FUND.

Balance per last Statement		$2094 65
Rents Collected		994 90
Ground-rents Collected		872 02
Cash received. Principal of yearly ground-rent for 52$\frac{50}{100}$ Dollars. E. S. Mount Holly Street, 30 feet north of Dickinson St.	$875 00	
Seventy days' Interest at 5 per. cent	9 63	
Notary's Acknowledgment	1 00	885 63
		$4847 20
For Books	$2105 56	
Taxes and Water-rents	195 43	
Repairs to Properties	378 92	
Collecting	93 34	
Miscellaneous	57 45	
		2830 70
Balance		$2016 50

$1750.00 of the above balance to be re-invested.

INSTRUCTION AND LECTURE FUND.

Balance per last Statement		$ 142 70
Miscellaneous	$56 05	
Transferred to General Account	86 65	
		142 70

MUSEUM FUND.

Balance per last Statement	$ 5 00
Income from Investments	50 00
	$55 00

VAUX FUND.

Balance per last Statement		$ 477 30
Income from Investments		600 00
		$1077 30
Minerals	$550 63	
Miscellaneous	14 59	
		565 22
Balance on hand		$512 08

Mrs. STOTT FUND.

Income from Investment	$ 100 00
Transferred to General Account	100 00

BOOK ACCOUNT. (Jos. Jeanes' Donation.)

Balance per last Statement		$ 37 13
Books	$34 00	
Transferred to General Account	3 13	
		37 13

HENRY N. JOHNSON FUND.

By Cash paid Collateral Inheritance Tax		$1059 70
" " Refunded Penna. Co. for Ins. on Lives, etc., overpaid in settlement		35 50
" " Expenses Attending the Settlement of Est. H. N. Johnson, dec'd.		13 08
" " Grading side-walk in Upsal St		167 37
" " Repairs to Properties		518 25
" " Collecting		87 60
		$1860 54
To Cash received Penna. Co. for Ins. on Lives, etc., in Settlement of Est. H. N. Johnson, dec'd.	$859 93	
" Rents Collected.	618 80	
" Ground-rents Collected	94 50	
" Mortgage Interest and Tax collected	40 50	
" Six months' Int. on $1000 Lehigh Valley's Bonds	25 00	
		1638 73
Balance due by Academy		$221 81

The election of Officers, Councillors, and Members of the Finance Committee, to serve during 1886, was held, with the following result:—

President, . . .	Joseph Leidy, M. D.,
Vice-Presidents, . .	Thomas Meehan,
	Rev. Henry C. McCook, D. D.
Recording Secretary, .	Edward J. Nolan, M. D.
Corresponding Secretary,	George H. Horn, M. D.
Treasurer, . . .	Wm. C. Henszey.
Librarian, . . .	Edward J. Nolan, M. D.
Curators, . . .	Joseph Leidy, M. D.,
	Jacob Binder,
	W. S. W. Ruschenberger, M. D.,
	Angelo Heilprin.
Councillors to serve three	Thos. A. Robinson,
years, ...	Edw. Potts,
	Isaac C. Martindale,
	Theo. D. Rand.
Finance Committee, .	Isaac C. Martindale,
	Aubrey H. Smith,
	S. Fisher Corlies,
	George Y. Shoemaker,
	Wm. W. Jefferis.

ELECTIONS DURING 1885.

MEMBERS.

January 27.—Mrs. Cornelius Stevenson, J. Addison Campbell, Burnett Landreth.

February 24.—Charles Harrod Vinton, M. D., Henry Leffman, M. D., S. Frank Aaron, Edward Longstreth.

April 28.—Philip Laurent, Rev. J. R. Danforth, D. D.

November 24.—Charles S. Dolley, M. D., Chas. N. Davis, John H. Campbell, W. D. Averell, W. G. A. Bonwill, M. D.

CORRESPONDENT.

May 26.—Antonio de Gregorio of Palermo.

ADDITIONS TO MUSEUM.

ETHNOLOGY AND ARCHÆOLOGY.—A. L. Siler. Netting from Pueblo ruins, Utah.
M. Huffnagle. Mummy (and accessories) of the XIX dynasty, collected by Dr. Charles Huffnagle (on deposit).
Mrs. Thomas Say. Leather stockings worn by Wm. Maclure.

MAMMALIA (Recent and Fossil).—H. C. Chapman. Skeleton of elephant.
S. F. Aaron. *Lepus callotis* (skull and skin), Texas; *Spermophilus grammurus?* (skin), Texas.
G. Raphael. *Blarina?* Beverly, N. J.
W. W. Jefferis. Tooth of fossil horse, Orange Co., Fla.
Florida Land and Improvement Co. (J. J. Dunne). Fragments of manatee bones, Manatee River, Fla.

BIRDS.—S. F. Aaron. 16 trays of eggs of North American birds.
T. G. Gentry. 181 nests of North American birds.
Zoological Society of Philada. *Cyanocorax chrysops*, Brazil; *Micrathene Whitneyi.*
T. L. Harrison. A collection of North American birds (no stated localities).
M. J. Middleton. Hooded merganser and whistling swan, Chesapeake Bay.
J. H. Carr. Impeyan pheasant, India.
W. H. Jones. *Aulacorhamphus albovitta, A. hæmatopygius, Sturnella sp., Cotinga maynana* and *Tanagra lunulata*, from Columbia, S. A.

REPTILES (Recent and Fossil).—H. C. Chapman. *Ceratophrys cornuta*, Surinam: *Ungalia maculata, Diadophis rufescens, Hyla septentrionalis, Hylodes planirostris; Anolis Sagrei* and *A. principalis*, Nassau, New Providence.
W. W. Jefferis. Carapace of *Chelydra serpentina*, Lenni Dam, Pa.

FISHES (Recent and Fossil).—R. D. Casterline. Two specimens from the Green River Shales (Eocene), Wyoming.
W. Dougherty. *Fistularia tabacaria.*
Purchased. 45 species of fishes from the southern and western waters of the United States, collected by D. S. Jordan and S. E. Meek. 75 bottles of fishes from the waters of the southern and western United States, collected by D. S. Jordan and S. E. Meek.

MOLLUSCA. Rafael Arango. 7 species marine shells from Cuba, etc.
S. Archer. 158 species marine shells, Singapore.
J. F. Bailey. 10 trays marine shells from Australia.
W. T. Bednall. 11 species marine shells from Australia.
W. G. Binney. *Helix germana*, Santa Cruz, Cal.; *Helix Levettei*, Santa Fe Canyon, New Mexico.
Rev. W. M. Beauchamp. 10 species fresh-water shells from the State of New York.
J. J. Brown. 2 species fresh-water shells from the Bermudas and Bahamas.
H. F. Carpenter. *Amnicola grana*, near Providence, R. I.
H. C. Chapman. 8 species marine shells from the Bahamas.
Conchological Section (by purchase). 97 species shells new to the collection, many types; 48 species of marine, land and fresh-water shells from Sicily; 72 species marine and fresh-water shells from Australia, Cape of Good Hope, India, etc., 100 trays land, marine and fresh-water shells from France, collected by M. Bédard, 16 trays land and fresh-water shells from Missouri, collected by O. A. Crandall; 175 species land, marine and fresh water shells from England, collected by H. Crowther.

78 species of land and fresh-water shells, principally from New Caledonia, collected by G. Dupuy; 103 species of land, marine and fresh-water shells from France, collected by A. Granger; 217 species of land, marine and fresh-water shells from Florida, collected by H. Hemphill; 88 species of land shells from France, collected by M. Locard; 39 trays land and fresh-water shells from Asia, Africa, Tasmania and New Caledonia, collected by E. Marie; 42 species marine shells from Florida, collected by M. A. Mitchell; 137 trays land and fresh-water shells from France, collected by Lieutenant Wattebled.

John Ford. 8 trays of marine shells from Rhode Island and Massachusetts; suite of land and fresh-water shells from Philadelphia county, Pa.; *Helix Stimpsoni; Teredo navalis*, in ebony wood from Macassar, Java; *Pholas truncata* and *P. crispata* from Sea Isle City, New Jersey; 5 species marine and fresh-water shells from Narragansett Bay, etc.; *Melo Indica; Hippopus maculatus* and *Trochus pica; Littorina irrorata* Say (young) and *Modiola plicatula* Lam. from Atlantic City, New Jersey.

Dr. F. M. Hamlin. 2 species marine shells from Bermuda.

Dr. Hartmann. 5 photographs of type species of *Partula*.

Benton Holcomb. 11 species of land and fresh-water shells from Connecticut.

F. W. Hutton. 11 species marine shells, New Zealand.

W. W. Jefferis. *Helix pomatia* and *Helix hortensis* from Heidelberg.

C. W. Johnson. *Columbella avara, C. lunata* and *Odostomia impressa* from Florida.

C. R. Keys. *Sphærium sphæricum* Anth. from Kennedy's Lake, Iowa.

G. W. Lichtenthaler. 23 species marine shells from the Sandwich Islands, Alaska, etc.; *Sphærium sulcatum* Lam. from Salem, Oregon.

C. R. Orcutt. *Lymnea humilis* Say from Todas Santos Bay, California.

H. L. Osborn. 31 species marine shells from Beaufort, N. C.

G. Howard Parker. *Sphærium striatum* Lam., Ridley Creek, Delaware Co., Pa.

H. A. Pilsbry. *Gundlachia Meekiana*, Rock Island, Ill.

J. B. Quintard. 3 species of fresh-water shells from Silver Lake, Kansas.

J. H. Redfield. *Pecten Magellanicus*, Mt. Desert, Maine; *Littorina littorea*, Martha's Vineyard, Mass.

U. C. Smith. *Pholas truncata*, Anglesea, N. J.

Hon. F. E. Spinner. *Unio Buckleyi* Lea, Lake Monroe, Fla.; *Planorbis glabratus* Say, St. John's River, Fla.

R. E. C. Stearns. 4 species of marine and fresh-water shells, from California, Tehuantepec and Peru.

L. H. Streng. *Purpura hæmastoma*, Panama; *Nerita fulgurans*, Nicaragua; *Unio nasutus* and *Physa integra*, Michigan; 2 fresh-water species from Vancouver Island.

G. Test. Egg capsules of *Fulgur canaliculatus*, from Sea Isle City, N. J.

J. H. Thomson. 7 species of land and fresh-water shells, from Merida, Yucatan, and New Mexico; *Helix alauda* Fér., Cuba.

Henry A. Ward. Glove woven from the byssus of *Pinna pernula*, Mediterranean Sea.

Wm. Wheeler. *Cypræa angustata* and *C. edentula*, from Algoa Bay, South Africa.

J. Willcox. Egg cases of *Fulgur perversus*, Tampa Bay, Fla., and of *Fasciolaria*, Charlotte Harbor, Fla.; *Vivipara lineata* Val., and *Unio fuscatus* Lea, Orange County, Fla.

INVERTEBRATA (recent, exclusive of mollusks).—J. Ford. *Echinanthus rosaceus* and *Meoma ventricosa*, Elbow Key, Fla.; *Meoma ventricosa*, Nassau, New Providence; *Asterias ochracea*, Santa Cruz, Cal.; *Strongylocentrotus purpuratus?* California; *Oreaster*, Nassau; *Meyenia Leidyi*, Philadelphia.

H. C. McCook. A collection of Cicada architecture.
G. Günther. A collection of insects, Buenos Ayres.
C. Test. *Balanus eburneus*, Sea Isle City, N. J.
J. B. English. *Serpula dianthus*, Barnegat Bay, N. J.
G. J. Corson. Serpuloid worm burrows, Morris Cove, N. J.
C. McCormick. *Xanthodes nitidula* and *Apus longicaudatus*, Texas; *Gelasimus pugilator*, Atlantic City, N. J.; *Ixodes*, sp.? Texas.
E. Potts. *Pectinatella*.

INVERTEBRATA (Fossil).—J. Ford. *Orthis testudinaria*, from New York and Ohio.
W. W. Jefferis. Casts of *Venus*, Miocene of James River, Va.: a collection of Silurian and Carboniferous fossils from the west.
J. Wilcox. A collection of fossils, partly chalcedonized, from Tampa Bay, Fla. (Oligocene?)
C. McCormick. *Acidaspis tuberculatus*, Bushkill, Pa.; *Phacops Logani*, Dingman's Ferry, Pa.
Chas. Wachsmuth. Slab containing Crinoids, Carboniferous of Marshalltown, Iowa.
Florida Land and Improvement Co. (J. J. Dunne). *Conorbis*, n. sp. (*princeps*), Oligocene, of Manatee River, Fla.

PLANTS (Recent).—Prof. Thomas C. Porter, Lafayette College, Easton, Pa. *Holosteum umbellatum* L., from Harrisburg, Pa.
Mrs. Maria L. Owen, Springfield, Mass. 7 species rare plants, from Nantucket, Mass., and an abnormal form of *Kalmia latifolia* L., from Deerfield, Mass.
Dr. J. W. Eckfeldt, Phila. 160 species Lichens from Scandinavia, Austria, Hawaian Islands and N. America, all named and mounted, of which 91 are new to the collection.
Wm. M. Canby, Wilmington, Del. *Isoetes melanospora* Engelm., Stone Mt., Ga., new to the collection; 388 species from Europe, S. Africa and Australia, of which 77 are new to the collection.
Dr. Asa Gray, Cambridge, Mass. 217 species from China, Formosa, Siam, S. Africa, Australia, S. America and United States, of which 76 are new to us.
Prof. N. L. Britton, Columbia College, N. Y. 17 species Cyperaceæ, from Texas, of which 4 are new to us; Also *Montia Howellii*, Washington Territory.
J. B. Ellis, Newfield, N. J. 14th and 15th centuries of N. American Fungi.
Thos. Meehan, Phila. 365 species collected by him in 1883, in Western Colorado, Utah, California and Nevada, of which 18 are new to the collection; 21 species, mostly cultivated exotics, of which 17 are new to us.
Mrs Fanny E. Briggs, La Center, Washington Terr., through Thomas Meehan 51 species, collected by her in Washington Terr.
California Academy of Natural Sciences, by Rev. E. L. Greene and Mrs. Mary K. Curran, Curators 24 species of rare California plants, of which 18 are new to the collection.
Isaac C Martindale, Camden, N. J. 5 species plants from western North America, of which 3 are new to us.
Isaac Burk, Philadelphia. *Helianthus giganteus* L. *Helianthus* (doubtful sp.). *Senecio tomentosus*, from Cape May, N. J., and 19 species from ballast deposits at Kaighn's Point, mostly of South American origin, of which 6 are new to the collection.
Mrs. Flora E. Haines, Bangor, Me. *Petasites palmata* Gr., from near Bangor, Me.

Aubrey H. Smith, Phila. *Silphium perfoliatum* L., and *Gordonia pubescens* L'Her., with its fruit, from Bartram's Garden, Phila.

Dr. Emil Bessels, Washington, D. C. 13 species arctic plants, collected on Voyage of Polaris in July, 1872, Lat. 81°–82° N., and Long. 61° W.

J. Donnell Smith, Baltimore, Md. 26 species from southern United States, of which 3 are new to us.

John H. Redfield. 67 species from western N. America, of which 56 are new to us.

299 species, collected by C. G. Pringle, in Arizona and Iowa, in 1884, of which 114 are new to the collection.

16 species N. American grasses, mostly from Florida, of which 6 are new to us.

143 species, collected by him on N. England coast, mostly from Maine.

Friesia refracta Klatt, Cult., new to us.

PLANTS (Fossil).—J. Ford. 5 trays coal plants, Schuylkill Co., Pa.

L. H. Lightbipe. A collection of fossil plants and plant impressions, from the Cretaceous clay of Woodbridge, N. J.

ROCKS AND MINERALS.—W. W. Jefferis. Dog-tooth spar, Mineral Point, Wis.; magnetic sand, Lake Champlain; iron pyrites, changing into limonite, Berks Co., Pa.; corundum, Chester Co., Pa.; fossiliferous limestone, Cincinnati; iron pyrites, E. Whiteland, Pa.; silurian limestone, Ohio; blende and galena, Cumberland, England; quartz, from dolomite of Poorhouse Quarry, Chester Co., Pa.; quartz, from Lewis Co., N. Y.; gneiss and limestone, from Van Arsdalen's quarry, Pa.; leucite, from Vesuvius; quartz. Hot Springs, Ark.; calamine, pseudomorph after calcite, Mineral Point, Wis.; granular quartz, Dixon's, Del.; corundum, Newlin, Pa.; pyroxene, Burgess, Can.; garnet, Lancaster, Mass.; fluor spar, Philadelphia; massive garnet, Birmingham, Pa.; granite, Triassic shale, no loc.; Potsdam sandstone, Gouverneur, N. Y.; lignite, Bonn, Germany; amygdaloidal melaphyre. Oberstein, Germany; melaphyre, Hettstadt, Germany; trachyte, Siebengebirge, Germany; lithographic slate, Bavaria; toadstone, Newburyport, Mass.; buhrstone, Paris, France; amygdaloid, Round Hill, Mass.; blue quartz, Chester Co., Pa.; schist with magnetite (loc.?); wavellite, E. Whiteland, Pa.; blue quartz, East Creek, N. Y.; actinolite, Delaware Co., Pa.; hematite, Bernisof; mica slate, Warren, N. H.; corundum (altered), New Lynn, Pa.; hornblende, apatite and sphene, Rossie, N. Y.; limonite, Algeria; muscovite, Pennsburg, Pa.; muscovite, Chandler's Hollow, Del.; hornblende, Russell, N. Y.; cadmiferous blende, Wilkenradt; pyrite, smithsonite and sphalerite, Mineral Point, Wis.; quartz, Media, Pa.; polyadelphite, Franklin, N. J.; red-spotted porphyry, Lynn, Mass.; polyadelphite and rhodonite, Franklin, N. J.; corundum in Indianite, Delaware Co., Pa.; danburite (loc.?); talc, East Bradford, Pa.; phlogopite, Rossie, N. Y.; phlogopite, Burgess, Can.; talc, Rochester, N. H.; radiated mica and damourite, Chester Co., Pa.; cerussite, Mineral Point, Wis.; calcite, Bilbao, Spain; rutile and dolomite, Chester Co., Pa.; scapolite, Bolton, Mass.; almandine, Dixon's, Del.; tourmaline, Thousand Islands.

D. S. Martin. Carrara marble bored by sponge, Long Island; marmolite, Hoboken, N. J.; crust from Saratoga "Geyser Spring;" crust from "Champion Spring," Saratoga; Eozoon rock, Thurman, N. Y.

S. E. Hudson. Lignite, from Egg Harbor, N. J.

J. Ford. Fossiliferous pebbles, Fairmount Park, Pa.

I. Lea. A series (51 trays) of Triassic rocks and organic impressions from Pennsylvania; a series (35 trays) of rock fragments and plant remains from the Permian, Trias and Lias of Alsace-Lorraine and southwestern Germany, named in part by Prof. Schimper.

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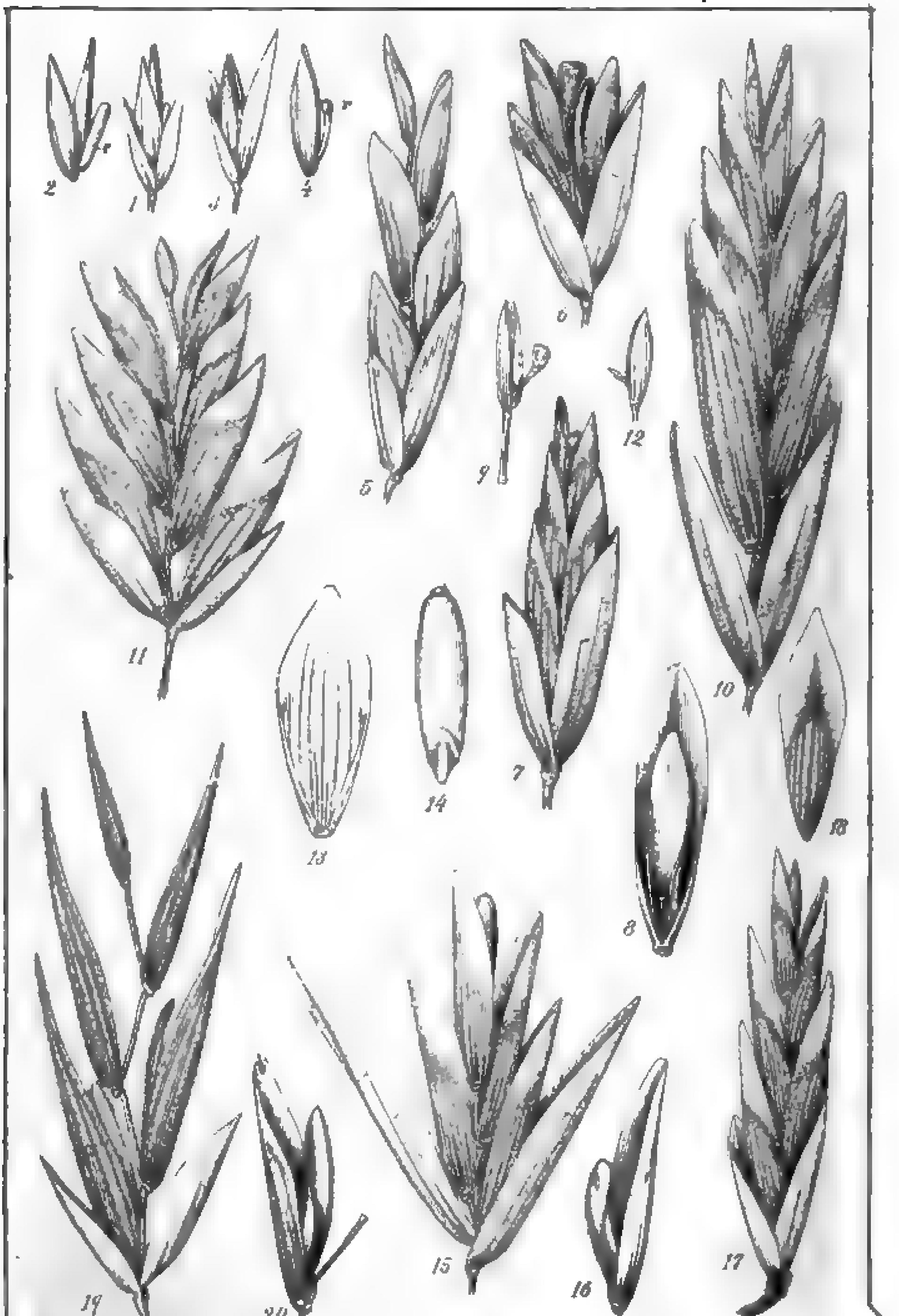

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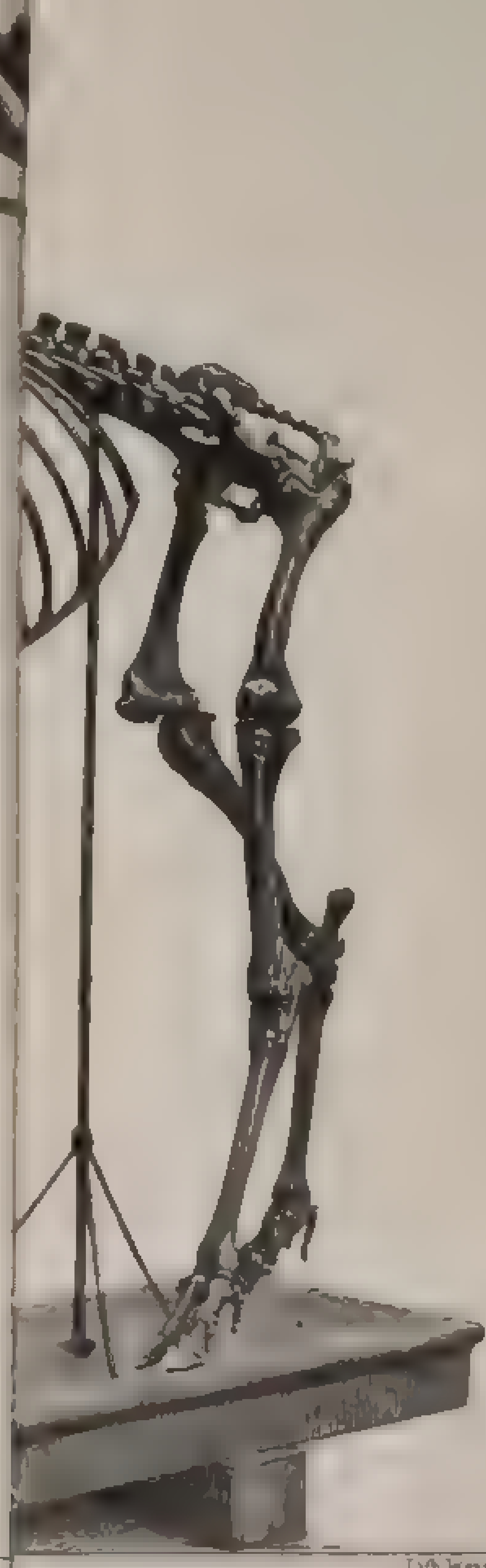


Lith Werner & Winter Frankfort M

MAP OF

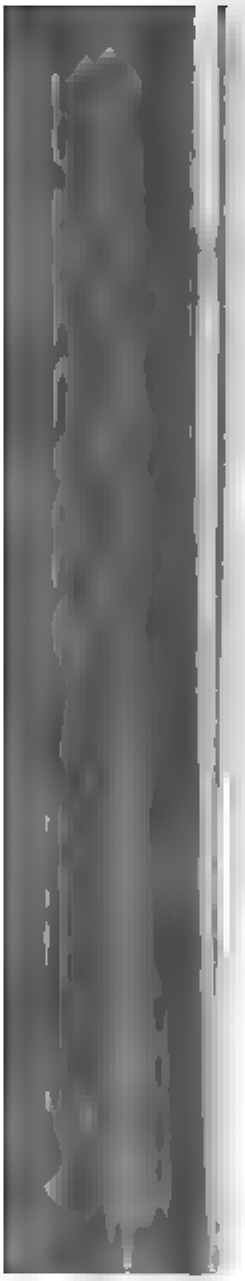
MARGINAL KAMES

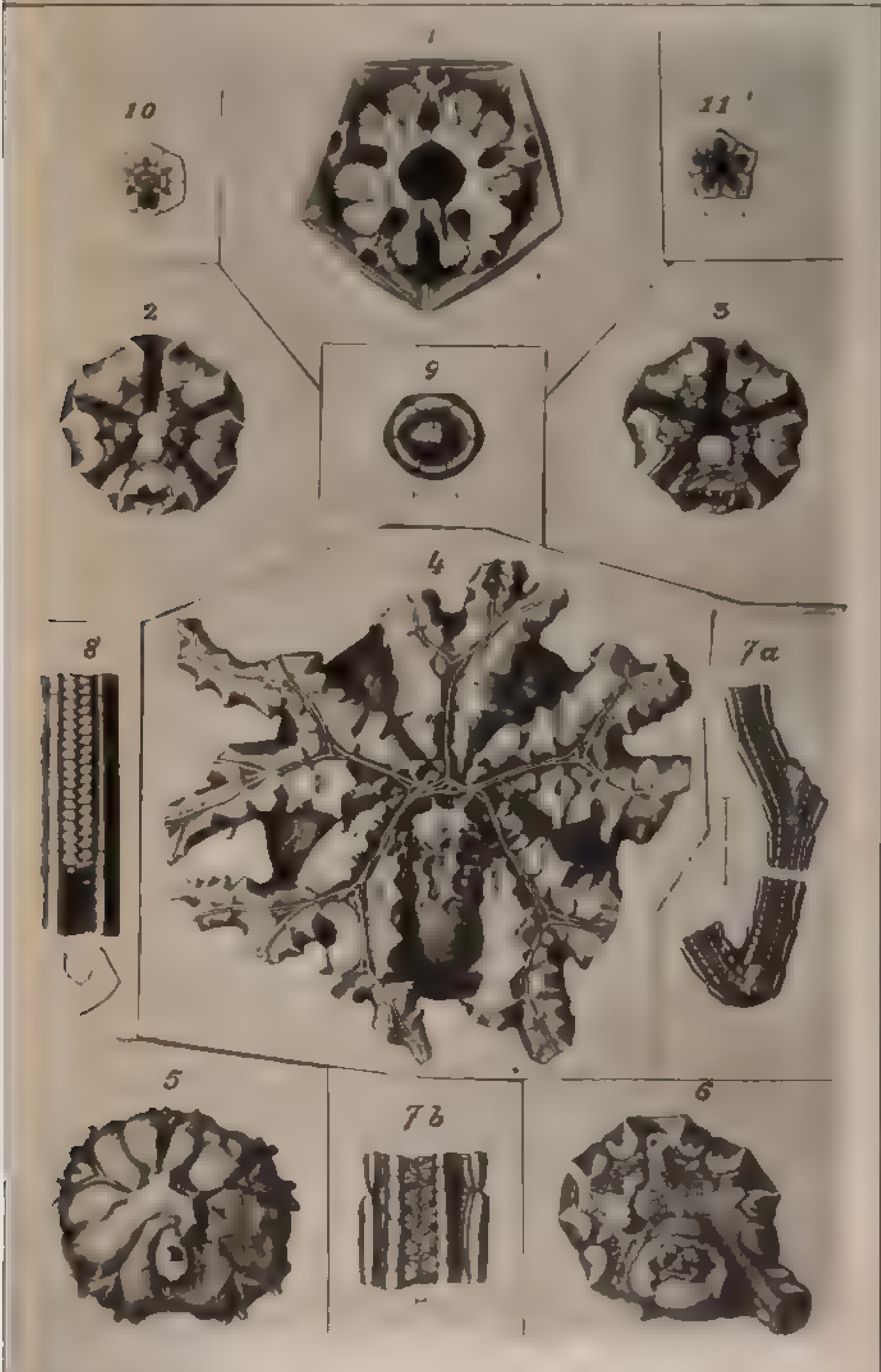
IN EASTERN PENNSYLVANIA,

BY

H. CARVILL LEWIS.

The Terminal Moraine and Kames are marked in red.





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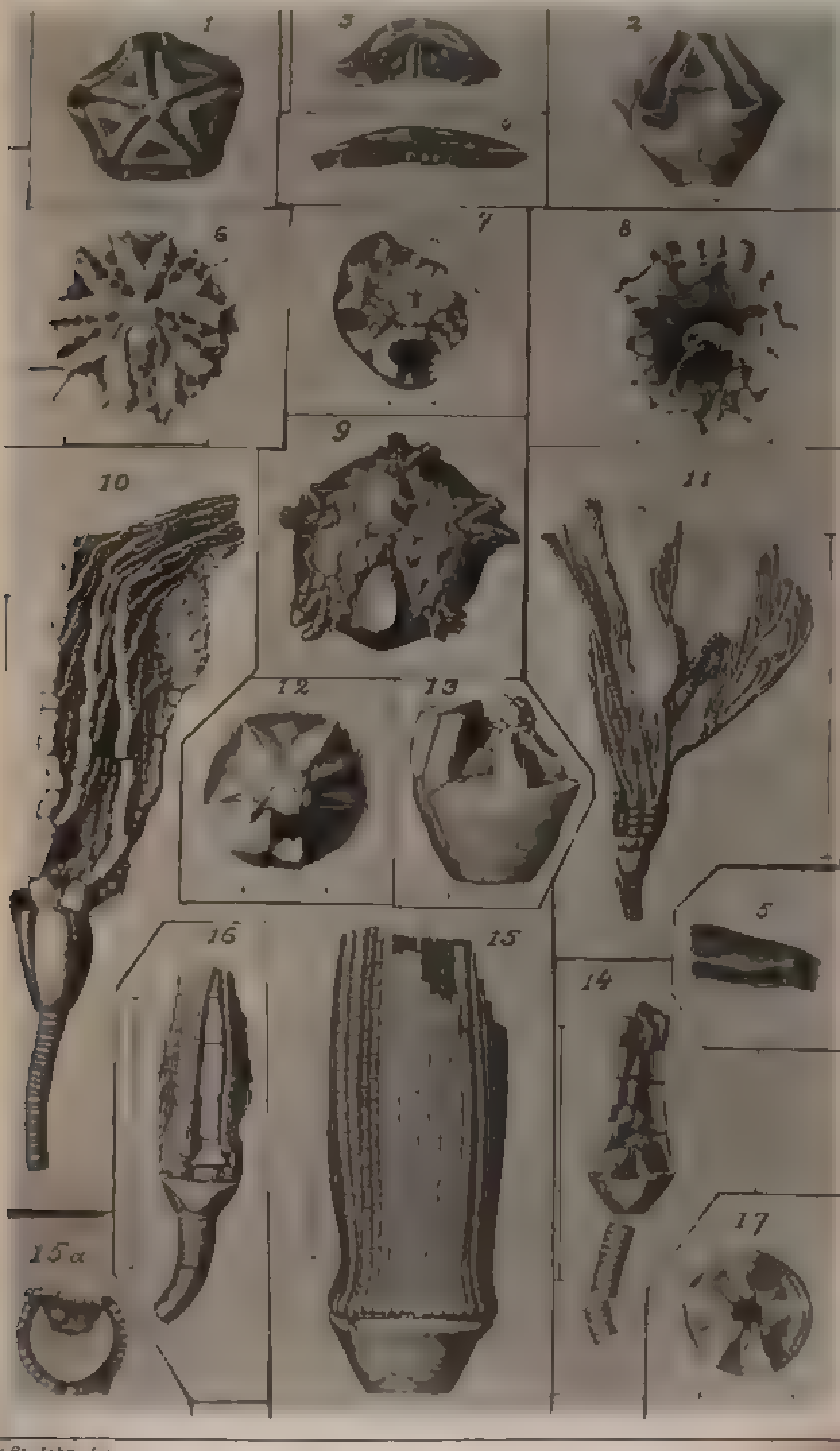

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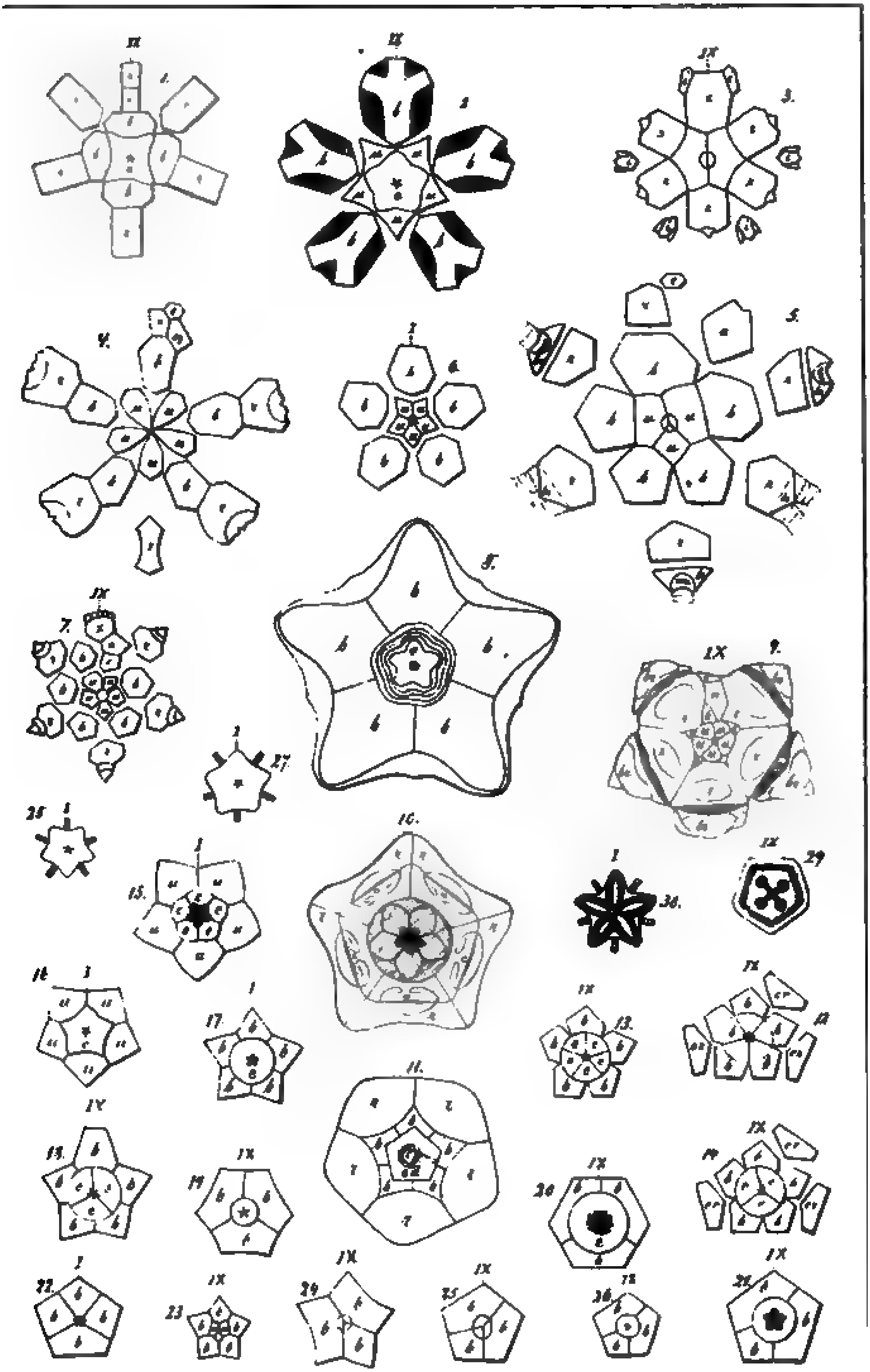

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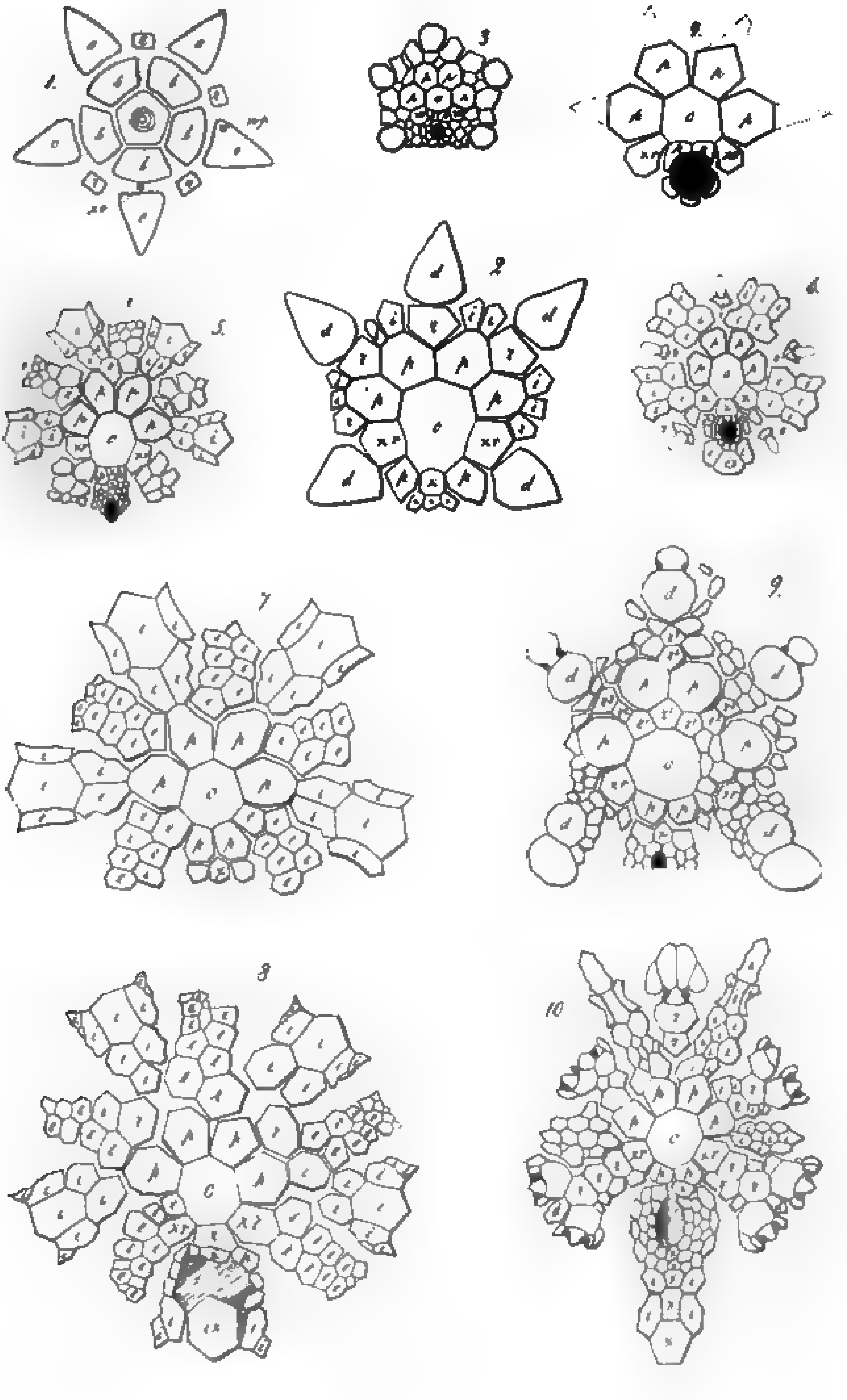

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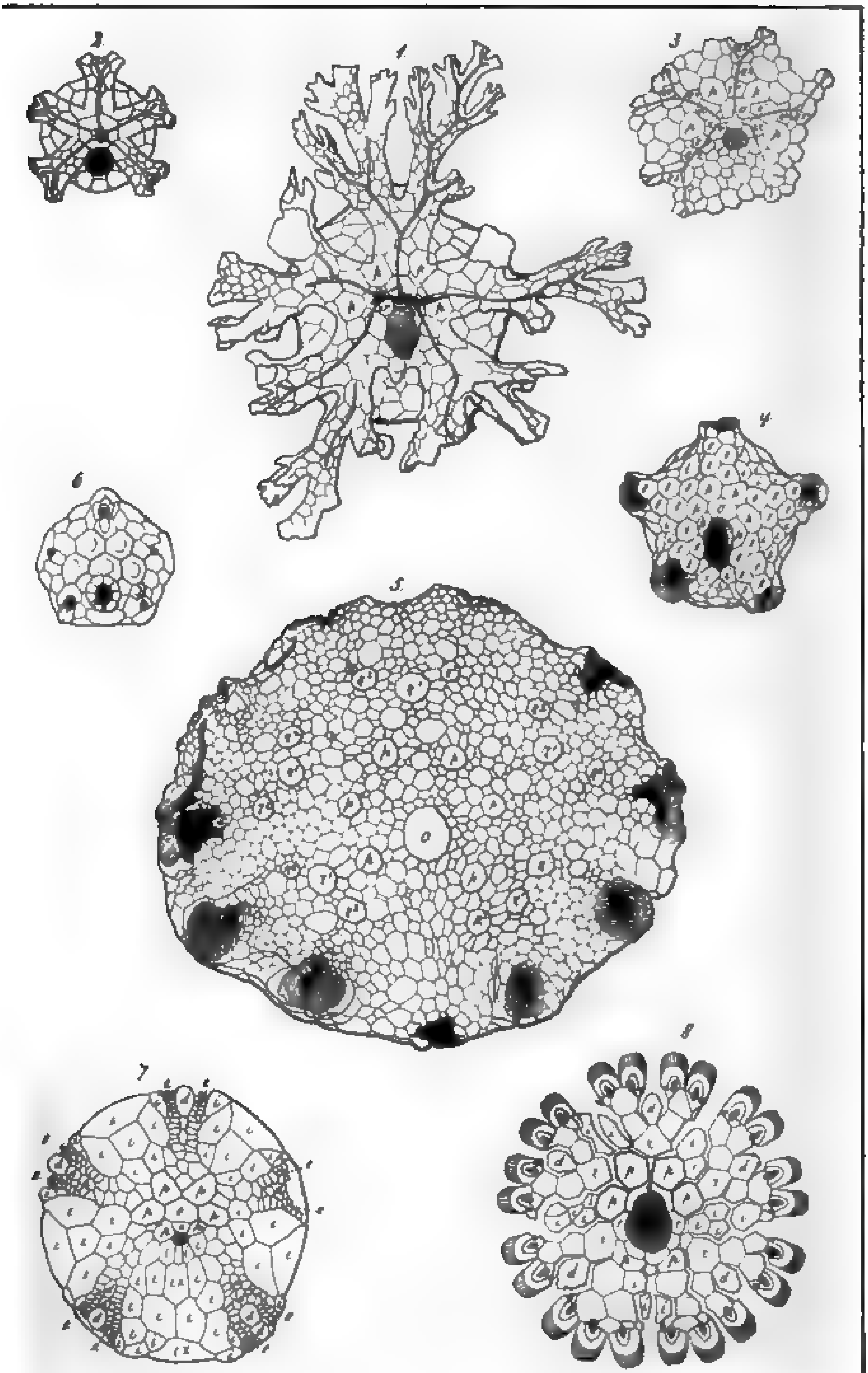

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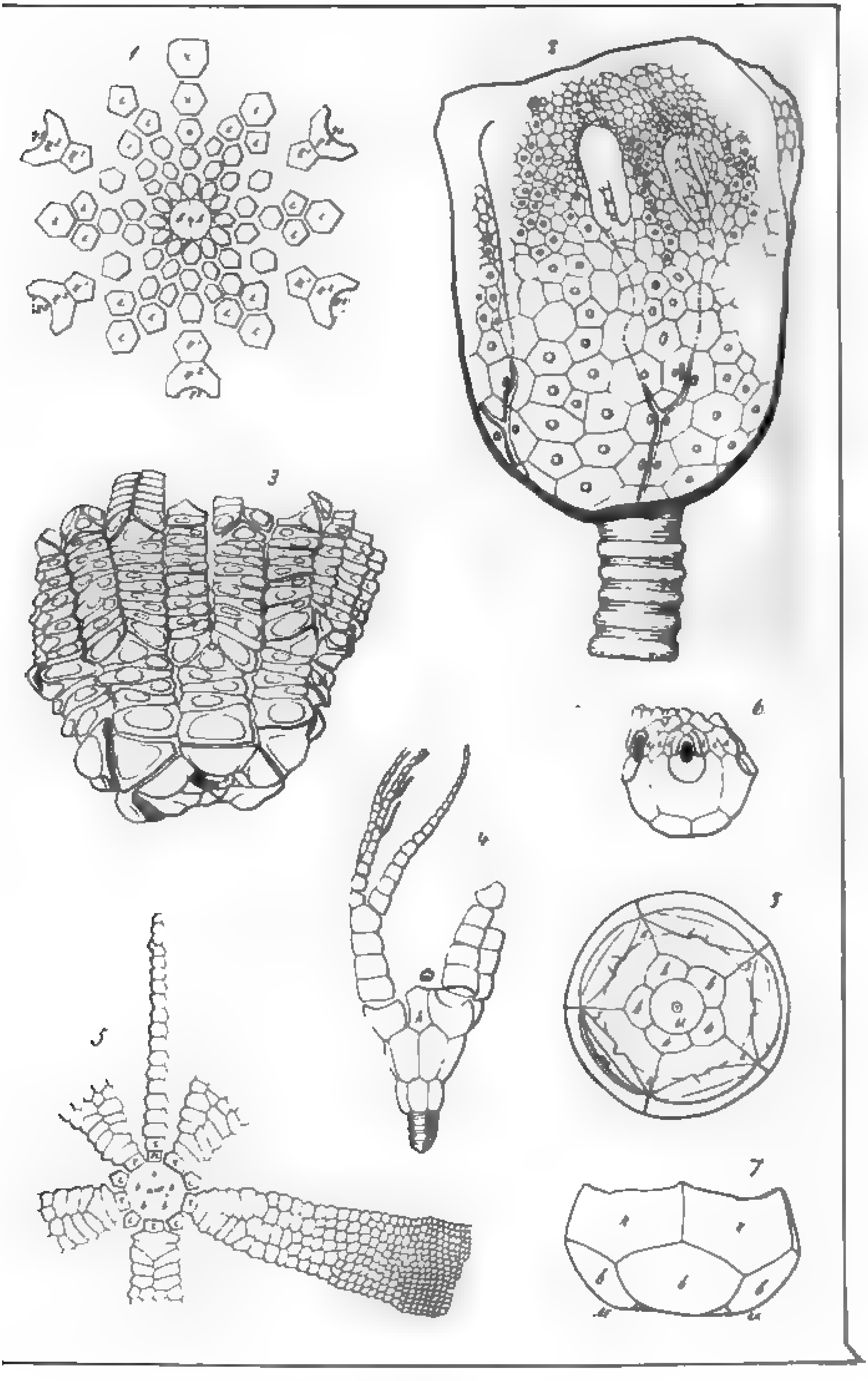

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